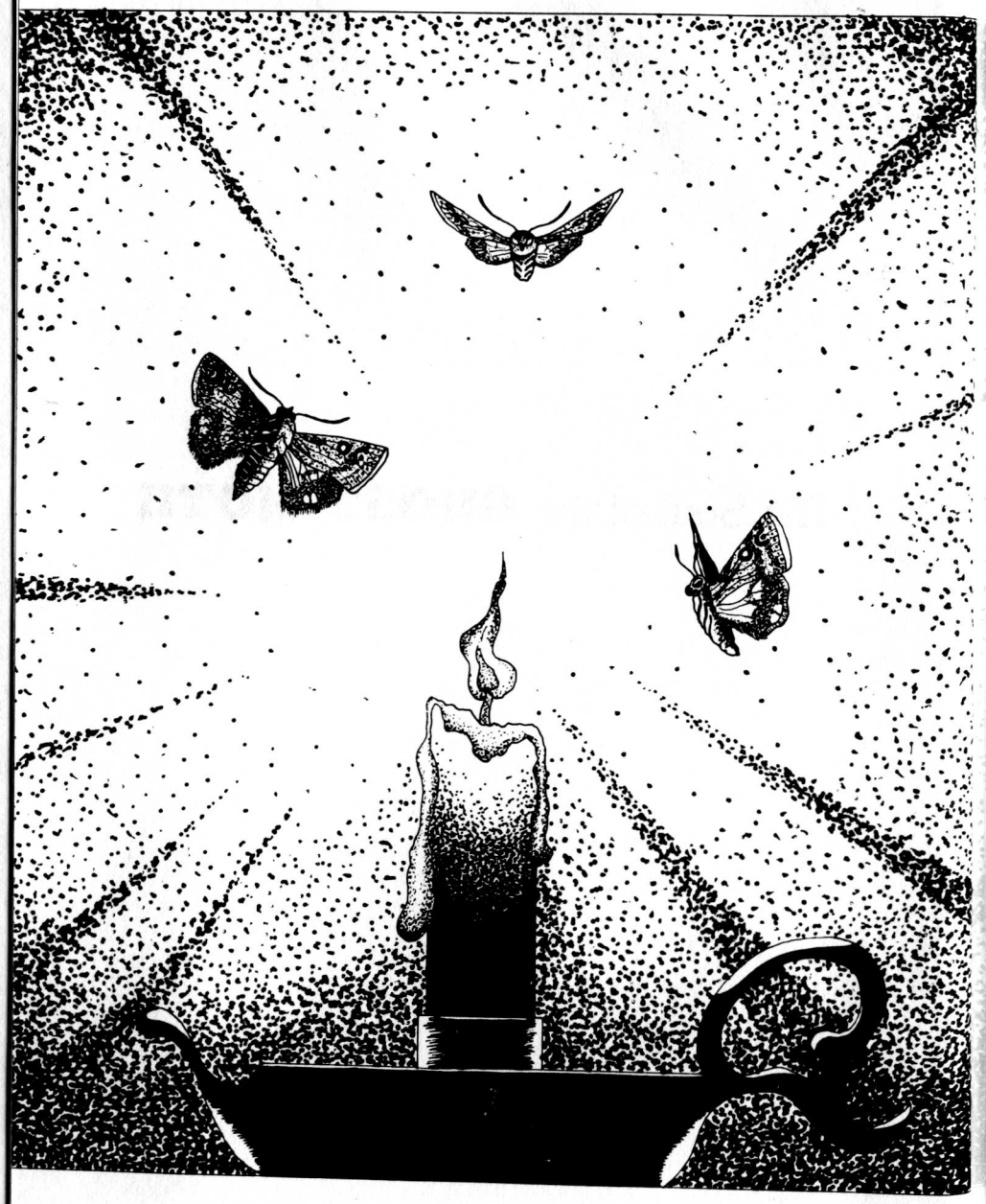

The Soul of the **GHOST MOTH** Paths of a Naturalist

By Philip S. Callahan

Foreword by Charles Walters, Jr.
Pen Drawings by the Author

The Devin-Adair Company
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FOR ALL THE PEOPLE IN THE WORLD
WHO FEEL AS I DO.

The goose stands alone
on one leg
in the middle of Payne's prairie.

Is it a little goose
or a big goose,
or a grey goose or blue,
or a goose from Canada?

I don't know, and perhaps
I never will,
for I never count or identify
but watch them grey or blue
against the rain drenched prairie sky.

Books by Philip S. Callahan

INSECT BEHAVIOR
INSECTS AND HOW THEY FUNCTION
INSECT EVOLUTION
THE MAGNIFICENT BIRDS OF PREY
BIRD BEHAVIOR
BIRDS AND HOW THEY FUNCTION
TUNING IN TO NATURE
THE SOUL OF THE GHOST MOTH

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Foreword

One morning somewhere along the way, Philip Callahan "jumped out of bed and wrote in his notebook, *all life is nonlinear.*" He might have added—and he probably did in his thinking—that all of life's manifestations are the result of many coincidental, contingent factors. The simplistic assumptions called linear thinking couldn't answer many questions or explain many answers. Worse yet, single factor thinking couldn't get the answers because it didn't even know the questions in the first place.

Callahan is an entomologist, ornithologist and a philosopher of life. In these combined roles, he has written a little book that is both a paean to the scientific system and an apostrophe to the free spirit. It took these combined roles to create the background for *Soul of the Ghost Moth,* to unravel each profound cause of the cause. In the process, a shattering lesson comes through, one we all ought to ponder. It is simply this:

Most of what is generally called the scientific system is not science at all, but merely procedure. The procedural aspect calls for setting up experiments that eliminate other possibilities, or it deals with making instruments that enable the investigator to find what he is looking for. The backbone of a true scientific system, however, has to do with asking the right questions, not procedure. And in order to ask the right questions, a scientist has to understand the meaning of *cause.*

Every phenomenon or act preceding another could be considered a cause, it being the function of logic and insight to link cause to effect. Cause is little more than an order of succession in a time frame, responsibility fading away and yet never disappearing entirely before reaching back to the First Cause—the Creator.

A scientist can only ask the right questions after his life has absorbed the experiences that lead him to a vision of the Creator's handiwork, hence the right question. New discovery is accomplished by the mind and soul of the whole person, and not by mechanical procedure in some air-tight intellectual compartment. It is only after the right question has been asked that investigators can properly invoke the statistical system to relate cause to effect. Indeed, when science falters, it is because no one has asked that question.

This has been Callahan's role, and it forms the hauntingly beautiful poetry of this book. As his soul matured—whether walking across China and the Middle East, shoveling coal in a tramp steamer, or tracking airplanes and insects in Ireland—he found himself peeling away layer after layer of lesser causes to get at the real thing. The answers here are fresh and startling.

They remind me of lines in a poem with a Latin name —*Natura Enim non Nisi Parendo Vincitur . . .*

Then come those humbler men of heart
With no completed scheme,
Content to play a modest part,
To test, observe and dream.
Till out of chaos come in sight
Clear fragments of a whole;
Men, learning Nature's ways aright,
Obeying, can control.

The beauty in Phil Callahan's work lies less in that he sees fragments of the whole than in that he explains them all so that even children can understand.

Charles Walters, Jr.

Acres, U.S.A. Raytown, MO.

Introduction

The Soul of the White Ant was a small volume written in 1937 by Eugène N. Marais. Marais was a literary vagabond who studied the social structure of baboons and white ants (termites) in his veldt homeland in the Afrikaans-speaking region of South Africa. He was a journalist-poet-lawyer whose real love was the study of living creatures.

For a considerable period of time he chose to leave civilization and live in a "rondhavel" (hut) in the wild Waterberg mountains. While living there he made friends with a group of baboons. He was the first person to undertake the study of primates by living within their social group.

During this same long mountain sojourn he also studied the social behavior of the white ants. He was convinced that the complex termitary was held together by a powerful, but unknown force—a sort of psychic communication system. He used the word psyche in most of his books but interchanged it often with the word soul—thus the title of his book.

He held that the collective psyche of the colony was so powerful that the entire colony could be considered a single living organism. In his view, the queen represented the reproductive system, and the workers the blood cells carrying nutriment through the colony "body." The unknown psyche he considered to represent the brain and nervous system as in a higher organism.

The view that an ant hill or termitary could be considered as a single organic unit, a sort of living being, was not a hypothesis of Marais' alone for the great Harvard ant specialist William M. Wheeler made the same analogy in his famous work on ants, and the Belgian writer-dramatist and

Nobel Prize winner, Maurice Maeterlinck, presented a similar idea in his beautiful book, *The Life of the Bee.*

In certain entomological circles the argument continues to this day as to which of these gentlemen had the idea first. Since, in all probability, none read the work of the other (Afrikaans, English and Flemish were the original languages) and since all the books were written at about the same time, they no doubt all arrived at their belief separately —Marais on termites, Wheeler on ants, and Maeterlinck on bees.

The history of science is filled with examples of researchers in separate parts of the world coming up with the same brilliant deductions at the same time. One of the best modern examples is the case of the laser which was being theorized and invented by an American, Charles Townes, at the same time as it was by two Russians, N. G. Basov and A. M. Prokhorov. All three of these researchers received the Nobel Prize for their work.

An even earlier example is that of the great biologists, Charles Darwin and Alfred Russel Wallace, both of whom formulated the theory of evolution and natural selection at the exact same time. These two men are to be admired not only for their elegant concept but also for the fact that they were gallant gentlemen. When they found out about each other's work, they joined forces and had their theory presented before the Royal Society at the same meeting.

Many such examples of simultaneous intellectual achievement can be cited and used to postulate a sort of collective psyche, or soul, for that sphere of man's endeavor that we call science. Certainly the great Jesuit priest-scientist and mystic, Teilhard de Chardin, agreed that there is such a phenomenon as a common scientific psyche and that it is constantly evolving toward and under the guidance of God.

Science, he maintains in his great philosophical masterpiece *The Phenomenon of Man,* will lead mankind to a

fusion of the intellect, and by means of that fusion to "oneness" with God. He calls mankind's final unity with God the "omega point." Teilhard was the first great philosopher to attempt a philosophical integration of the concepts of organic evolution, modern scientific technology, and religion.

For Teilhard, science and religion are not antagonists, as the so-called "age of reason" would have us believe, but rather two strong roots that support and feed the tree of life. They are an inherent part of the phenomenon of man.

Evolution, in the perplexed viewpoint of some, is random and thus undirected. In the view of almost all religious persons, such nondirection of life makes the concept of organic evolution appear to be ungodlike. Teilhard's philosophy disputes this scientific-religious nonsequitur and stoutly maintains that there is a higher psyche that directs evolution toward a final "completeness" of man's intellect. He tells us that our intellect is so confused by the deluge of scientific facts that we cannot see the overall view for the many obscuring details, or, in the words of that well-known saying, we "can't see the forest for the trees."

Teilhard does not believe that the forest is random, although its complex and detailed mixture of plants and animals would lead one to believe that it is. John Muir, the great American naturalist, put it in one short sentence when he said "everything is connected to everything else."

If we are to believe Eugène Marais, Teilhard de Chardin and John Muir, that everything is connected to everything else, and that is what the science of ecology also tells us, then we might also believe in an overall psyche or soul, a sort of worldwide communication system directed by the highest intellect of all—God.

Whenever through ignorance, malice or carelessness we destroy a part of that universal psyche, which manifests itself in both science and religion, we destroy a small part of our

collective intellect. Teilhard would say that we move backward instead of forward toward our omega point with God. That is what is so despicable about destroying life, or unnecessarily destroying any part of the environment for our own convenience or through selfishness. We destroy a part of the psyche that makes us one with God and also one with all of God's creatures.

If we are to believe, as do most people regardless of their formal religious beliefs, in an understanding and just God, then it should not be beyond the realm of reason that there is a universal psyche and that it manifests itself on a very high level in the scientific progress of mankind.

I have pondered upon such a God-directed concept of organic evolution for many years and the thought has directly influenced my own search for a physical basis for the idea. A scientist might say that it is my model for a "system" of life—a sort of universal communication array that binds all evolving organic matter together under the direction of one master intellect—God. This book records that search.

It has always seemed to me that if there is such a basis for life, then it must certainly lie in that one magic word *resonance.* Nikola Tesla was the first scientist to understand the force inherent in the concept of resonance; and it is only a concept, for we cannot see or touch resonance. It was Tesla who first learned how to put resonance (specifically, electrical resonance) to work in our technological age, but he also recognized it as an inherent force in nature before man discovered it.

I have constantly refined my techniques for searching out the secret of organic resonance in my laboratory. However, I do not believe that the laboratory alone can suffice for such an exploration. It is only by studying nature, as it exists in the great outdoors, that we can obtain a glimpse of that fusion of man's psyche to that of God—the universal soul.

I have searched for that psyche in forests and deserts,

swamps and moorlands, and in my own relationship with living creatures. I have caught a passing glimpse of that universal soul in the common bond between falcon and falconer, dog and master, pigmy and forest, and in numerous other such close relationships of man with other creatures.

A mechanistic philosopher will maintain that there is no such bond, but instead a conditioning of "nonthinking" creatures to man's own will. That, in my opinion, is why there are probably no mechanistic philosophers who are falconers. They do not see in the eye of a falcon what I have seen.

Eugène Marais must have had the same feeling when he was living and studying the white ants in the wilderness of the Waterberg mountains. Certainly his own soul emerges from his little volume.

Eugène Marais and Teilhard de Chardin lived at the same time and Teilhard, as a geologist, traveled extensively in South Africa. It is too bad that they never met for they would certainly have enjoyed one another's company.

P.S.C.

Gainesville, Fla.

The Silver-spotted Ghost-Moth: The moths have the habit of dancing in the air at sunset, and perform very peculiar gyrations over the spot where oviposition is to take place.

——Holland, *The Moth Book*

Some call it evolution, and others call it God.

——William Herbert Carruth

Each in His Own Tongue and Other Poems

Author's Note

This work was composed in 1977. At that time all of my research had concentrated on insect sex pheromones (chemicals released by female insects to attract the male). This is essentially the story of my discovery.

In simplest terms I have been able to demonstrate experimentally that merely tapping or vibrating certain organic molecules at extremely low frequencies (ELF), 1 to 1000 Hz, stimulates the molecule to emit narrow-band coherent or partially coherent far infrared radiation. There is at present no good theoretical or mathematical explanation as to why organic molecules should behave in this manner. It is the humming and vibrations of insects that indicate to me that such narrow-band far infrared emissions are stimulated by the ELF frequencies.

Since 1977 I have obtained such emission from plant hormones (ethylene), human hormones (testosterone), the human breath and numerous plant and animal scents. In all, I have accumulated over 10,000 such far infrared spectrums from organic molecules. I have also stimulated IR emission (which I call maserlike) at room temperature from water vapor doped with ammonia molecules. This is the first demonstration that water vapor can be stimulated to emit narrow-band radiation at room temperatures.

It is my firm belief that these maserlike radiations are the control frequencies of life. I believe that certain diseases—e.g., cancer—involve distorted communications between organic control chemicals and cells. Hopefully, we will be able to decode these maserlike signals and eventually cure such cellular malfunctions with far infrared maserlike radiation of extremely low energy.

With very few exceptions, almost all great scientific discoveries have been made by looking at nature and then devising experiments to determine how such natural systems work; e.g., the wing and flight. Theoretical and mathematical experimentation followed. It is indeed unfortunate that in today's technological climate the layman has been led to believe that science functions by postulating theories, utilizing mathematics, devising experiments to prove the theory. That is indeed putting the cart before the horse.

That there is no mathematical or theoretical model for my discovery does not make it any less a scientific fact. At present, I and several of my physically-trained scientific colleagues are working on mathematical models to describe my discovery. Scientists interested in my work may obtain reprints of my papers by writing to me.

Part I The Boy

Chapter 1

Accuse Not Nature

Accuse not Nature, she hath done her part;
do thou but thine, and be not diffident
of wisdom, she deserts thee not, if thou
dismiss not her.

Milton—*Paradise Lost*

The hawk left the topmost branch of the tall blue spruce and glided silently away. It was not a large hawk but rather candlestick slender with square shoulders and a long tail that fanned in and out much like a dainty Japanese fan. As it disappeared down Seventeenth Avenue in Denver, the Boy noted a tinkling bell and the long leather straps trailing from the fists of doubled talons. The Boy ran as fast as he could, but the hawk soon outdistanced him and he was forced to sit on the green grass of the parkway to regain his breath.

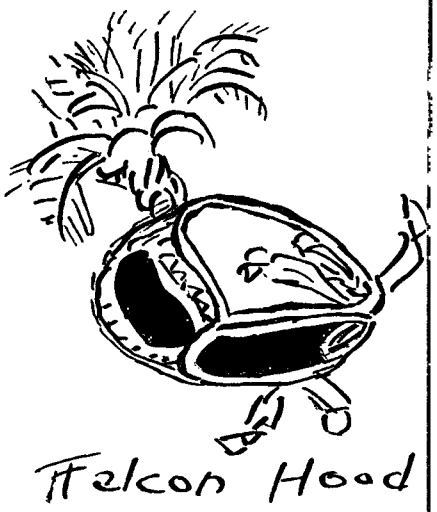
He knew he should leave the spot and go home for supper, but a hunger of a different sort held him to the grass.

It was a yearning to possess that slender bird and it flooded his whole being. He could neither understand nor explain it.

Every day he took the streetcar across Denver to the Jesuit high school. Each Friday after school he left the streetcar at Market Street to wander among the dusty second-hand book stores and leather saddle shops that lined that amazing street.

In one such store he found a book with the simple title, *Falconry*. It was written by an English gentleman and said on its cover that it belonged to "The Sportsman Library." There were not many pictures in the book, but the few it had showed sleek-looking peregrine falcons. Each photograph evoked the same yearning as the square-cut hawk he had seen on the parkway. From the books he learned that the long leather straps were called jesses and were used to hold the bird on the leash when it wasn't hunting for its master. The tinkling bell helped the falconer keep track of his bird in the deep woods. From the same book he also learned the source of the yearning in his heart, for Gilbert Blaine had written in 1936:

I believe that there exists deeply rooted in the nature of certain individuals some quality which inspires a natural liking for hawks. It may be an instinct inherited from our ancestors by whom the sport of falconry in its palmy days was pursued with an ardor amounting almost to a passion. Ask any keen and proficient falconer what first made him take up the sport. He will probably reply that he does not know, but that he was always, as far back as he can remember, fond of hawks.



The Boy knew in his soul that the Englishman was correct. His ancestors on his mother's side came from the town of Ainsa in Spain. That was his mother's name. Her forebears lived in a walled fortress called Ainsa Castle, so they must have kept falcons.

His father was of Irish descent, but the penal laws that England imposed on Ireland did not allow many Irishmen to go to school, much less marry nobility and keep falcons. That was the reason his father's forebears left Ireland and came to America where they could marry as they chose, or even keep falcons if they so desired.

The Boy, of course, couldn't be sure about his ancestors and only knew what he had heard his grandparents and parents talking about. They were no more certain of their ancestors than most Americans. In those days, Americans were decidedly not ancestor-oriented and made fun of the Japanese who were.

If the Boy had inherited a love of falconry, it must have been from his mother's side, but there was an even better reason for his believing Gilbert Blaine. The Boy had spent most of his early childhood in Memphis, Tennessee. His mother often took him to the city park zoo and his earliest memories of Memphis were of the high wire eagle cage. He could remember standing in awe at the fierce-eyed, white-headed bird staring back at him. He experienced those same yearnings for hawks even though he could scarcely know about falconry and such things.

Market Street brought out another powerful yearning in his being. It was the street in Denver where one could see what the Catholic priests and the Protestant ministers called "bad" movies. It seemed to be about the only thing the priests and ministers agreed on. The Boy's parents told him not to go to such movies, so of course he went because it was convenient to the streetcar line and because he couldn't help admiring the beautiful shadowy photographs of attractive

maidens in front of the movie houses. One such movie called "Ecstasy" was the story of a beautiful lady. The movie did not seem to have a plot, but the naked lady moved among the shadowy trees in a unique manner.

The photographs of peregrine falcons and the movie posters of the beautiful ladies seemed to inspire strange longings to possess both of those graceful creatures. Perhaps that was what the word ecstasy meant, but he did not really understand his yearnings for the ladies; no one had bothered to explain them to him.

If the priests and ministers considered the movie houses evil, then the farmers and readers of *Field and Stream* considered hawks and peregrine falcons even more so. They called hawks vermin. Even the Audubon Society had an ambivalent view of hawks and split them into bad guys that ate birds and good guys that ate rats and mice. However, the Boy failed to see how what one ate made one good or bad. With a sort of reverse logic he decided that because God made hawks they must be good regardless of what they ate. Now admittedly, logic is often a way of going wrong with confidence, but he also decided that because God made girls they must be good, too, whether or not they had their clothes on or off. His father must have felt the same way because he kept old World War I French magazines with beautiful poster drawings of elegant ladies in various degrees of undress. The Europeans tolerate such things and their art museums are full of beautiful paintings of plump undressed maidens.

When the Boy asked his father about shooting hawks, he told him it was all right to use a gun for target practice or to hunt game for sport or food, but that anybody who went around shooting songbirds or even hawks just for the hell of it ought to be arrested by the game warden—or better yet, if he himself ever caught such a person he would "cut his throat and jump on his belly." The Boy's father was an army

officer and used rather picturesque language at times.

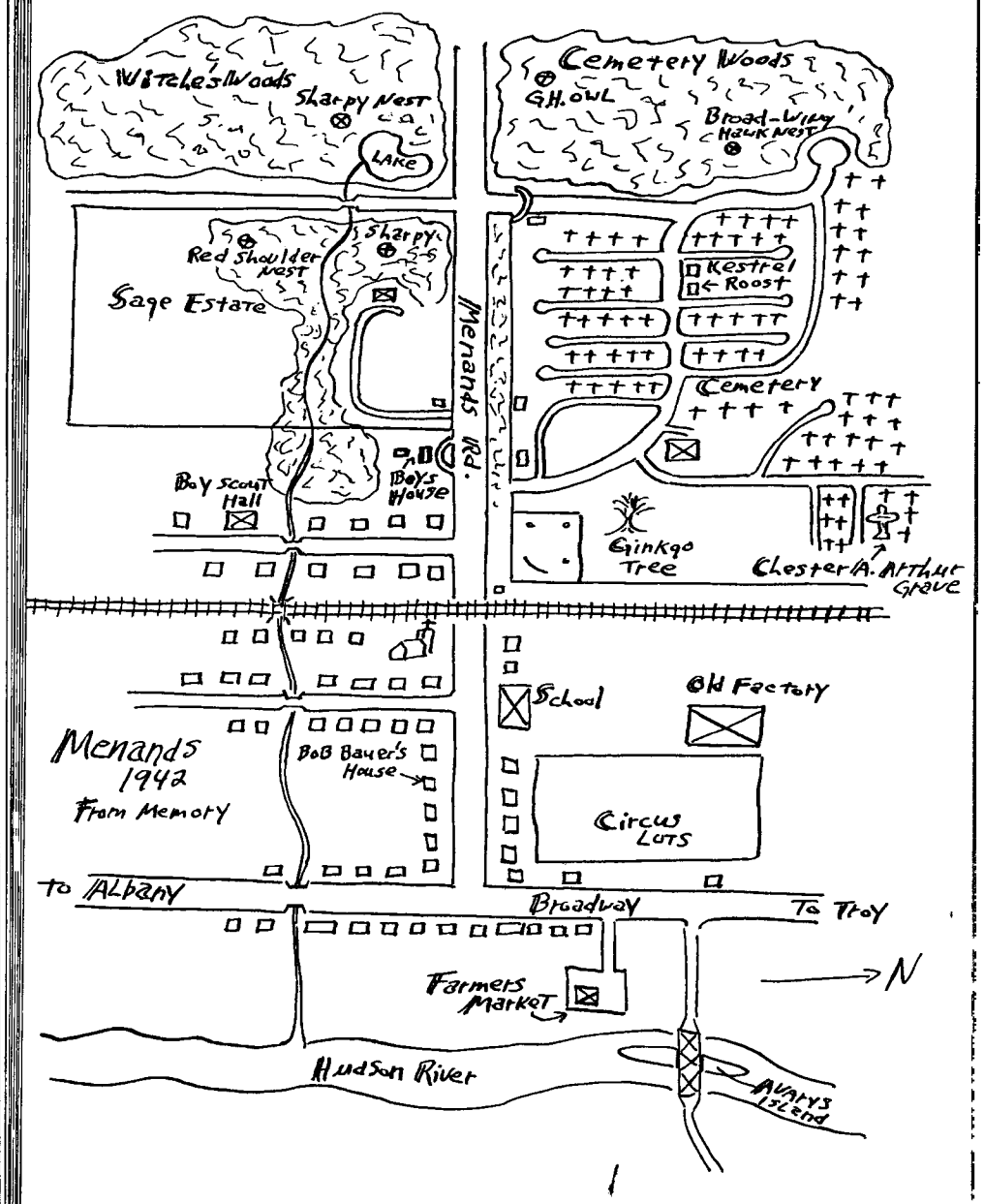
Since the Boy's father seemed to see little harm in hawks, or undressed girls, the Boy confined his confessions to the gentle old priest to really evil things—like the time he tore up his brother's wax and cardboard boat in a fit of jealous spite.

In the public library he found several books about hawks. The books told how raptors mated and where they nested. He also found a few books about humans and how they mated. The descriptions of life were so beautiful and mysterious that he decided very early in his life to become a biologist.

Not very long after he first saw the hawk with the jesses, he read in the *Denver Post* that there was a group of young falconers in Denver. The hawk on the parkway must have belonged to them. However, before he could meet the group, his family had moved to Detroit.

Not far from Seven Mile Road in Detroit, he found a woods where he spotted another slender square-shouldered hawk looking down from a tree branch. It was slate blue with a reddish breast so the boy knew it was a Cooper's hawk, a species that belonged to the bad guy category because it hunted birds. His book said it was an accipiter related to the English sparrow hawk, and a good bird for falconry but hard to manage. He thought that if it could be trained in the Middle Ages, it could be trained in 1939 just as easily. He resolved that when spring came he would obtain one of those slender blue hawks from a woodlot nest. In the meantime, he worked on his butterfly collection and watched the ants that walked in a long straight line between the tall weeds in the vacant lot next door. He also wondered why all the little moths that flew to the porch light always ended up inside the big glass globe.

He would find out about the actions of the moths one day, and also about why the ants walked in a long straight line.



Chapter 2

Resonance

Every boy should be interested in building a wireless receiver, something he can point to one day and say: "It works, try it." That's a great moment, when your friends hear music or voices or dots and dashes coming over the air.

Andrew White—1924 *Boy Scout Handbook*

The Boy tried to catch the big black and red sphinx moth. Its round vibrating body sent forth a hum like the compressor in the Kelvinator refrigerator by the kitchen door. Each time he swiped at it with his home-made net it slipped aside and shot upwards into the twilight sky. Finally it disappeared over the house. He ran to the front yard, but it was circling in wide sweeping orbits around the street light that shone against the big elm trees lining the avenue. The light attracted hundreds of insects during the warm summer months. It was a good place to collect insect food for his birds.

The Boy did not want to capture the moth for his insect collection. He wanted the sphinx to feed to his two little orange kestrels. Its plump body would make a nice snack for

the two bright-eyed falcons he had taken from the old dead tree in the Menands Cemetery.

He had read in Gilbert Blaine's book on falconry that Chinese ladies hawked butterflies with kestrels. The book also said that no uncultured race ever attempted to explore the mysteries of falconry. The Boy wondered if that meant that the Chinese were cultured but that Americans were not. He did not really care because he liked all the people who lived around him in the little Hudson Valley village of Menands.

His father had driven them there from Detroit in their V-8. The seats were stacked with suitcases so there was not much room for the pet magpie he had taken from a stick nest in Denver, much less for the downy Cooper's hawk he had found that spring in a Detroit wood lot. But his family were a patient lot so they took the birds along anyway.

Menands was a remarkable village. The long, steep Menands Road led down the hill from Little's Lake past the huge Sage estate and across the railroad tracks to the Hudson River. It was across the river in a hillock of white pines that the Boy saw his first long-eared owl and later found its nest.

In the winter when the trees were leafless, he would hike through the snow-covered woods spotting each tree that contained a stick nest and marking the location on a geological survey map. These maps cost a quarter each and showed the whole layout of the land on a scale of one inch to the mile. During that long snowy winter he found a sharp-shinned hawk's nest in Witche's Woods and another on the Sage grounds. A broadwing hawk and horned owl nested in the cemetery woods and there was a red-shouldered hawk's nest near the road that ran along the creek on the estate. His kestrel family roosted on the tops of the pillars that supported the roof of a large spooky mausoleum.

He collected owl and hawk pellets from the grass under that elegant white structure. Never did he imagine he would be as successful at finding raptor nests as he was that winter and spring, but of course that was a few years before DDT was invented.

Witche's Woods was a place of solitude in the winter and only the cracks of ice-burdened trees and the *chick-a-dee dee dee* of the little black and white eastern chickadee would break the early morning silence on those gray winter days. Sometimes if he were out late enough in the evening, the *wolf-wolf* of the great horned owl would float through the woods as the sun went down. The dry cold of the winter air, the gray sky, and the chickadees and nuthatches flitting about on the leafless tree limbs imparted to the winter woodlands a sort of melancholy but appealing bleakness.

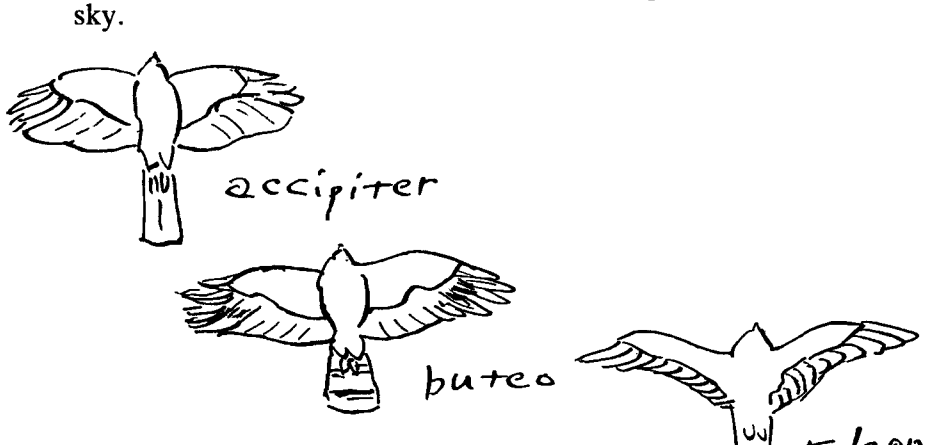
When spring came to the woods, the warblers passed through on their migration and the Boy obtained his first glimpse of the young redstart searching the tree tops for newly emerged caterpillars and spider egg sacks. Spring was the bright green time of year and the leaves of the sassafras and birch were a light delicate shade of green that furbished the whole forest canopy.

Along the river bottom lands the silver-winged dragonflies danced above the reeds and brown-tipped cat-tails. The early morning sun shining on the dappled marshes, and the red-winged blackbirds flashing their red coverlets conveyed a sense of freedom from any of the world's earthly wants; it was the sort of happiness things could not bring. That was long before industrial wastes had polluted that silver-green river valley.

The Boy got to know the farmers along the valley. In the spring he helped them cut their cabbage and load it at the riverside farmers' market. He could not know at that time

that the technologists would develop new farming methods that would threaten his high flying raptors.

He soon learned to tell the skyborn hawks and falcons that soared above the river valley. Peterson's field guide showed exactly what they looked like silhouetted against the blue sky.

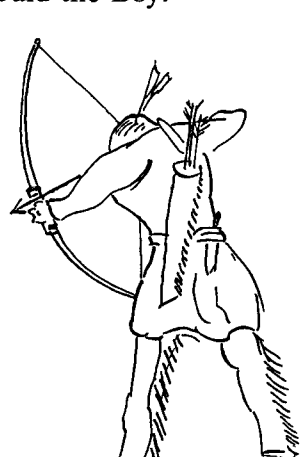


In the spring he could spot them—small specks drifting over the ancient brick shirt factories along Broadway or across the river above Troy.

He soon trained his little kestrels to fly to a swinging lure. When he was sure they would come to him from afar, he let them fly to the top of the big ginkgo tree at the edge of the baseball lot. There they sat until he released one of his street-light moths into the air. Then the falcons would dodge and dive after the high flying sphinx moths but usually the moth was better at dodging and darting than the little falcons. They could reverse direction 180 degrees so that if the birds were chasing one towards the cemetery woods it would quite suddenly reverse itself and be headed in the opposite direction. The kestrels could not make such quick reverse turns and they almost never caught one of those

choice morsels. However, the Boy believed those cemetery flights must be at least as beautiful as the flight of the English merlin against the moorland skylarks. What few English books there were on falconry described the high-ranging flights of merlin and skylark in glowing terms. The Earls and Kings and beautiful Ladies could hardly imagine a more delightful pastime—and neither could the Boy.

On long winter evenings after school, he spent his time absorbing the big volume his mother had given him called *Birds of America,* and reading his favorite book, *Two Little Savages,* by Ernest Thompson Seton. From that masterpiece of boy's fiction, he learned how to make a war bonnet and how to fashion a good hunting bow from mockernut hickory. In Witche's Woods he shot a rabbit with the bow and cooked it in front of his leafy lean-to.



He didn't much like hunting with his Cooper's hawk except for house sparrows and starlings—or the sphingid moths that his kestrels chased. In both cases the prey usually got away. It was the flight of those graceful birds that caused his being to feel what Seton called "glimmerings of exquisite thrill or pain"—thrill at the behavior of the birds and insects, and pain because there was no way to study their habits. Learning about insects was especially difficult for, although there were a few good books on bird behavior, there were very few readable books on insects, and the confusing variety of species made identification uncertain.

The Boy observed insects and helped his sister with her butterfly collection, but mostly he spent his time training his

Cooper's hawk. He knew that accipiter hawks usually capture their prey in a short sprint of a flight and kill on the ground. Sometimes the accipiters "still hunt" in the woods by perching in the upper branches of a tree and dropping swiftly on some unsuspecting prey that comes by.

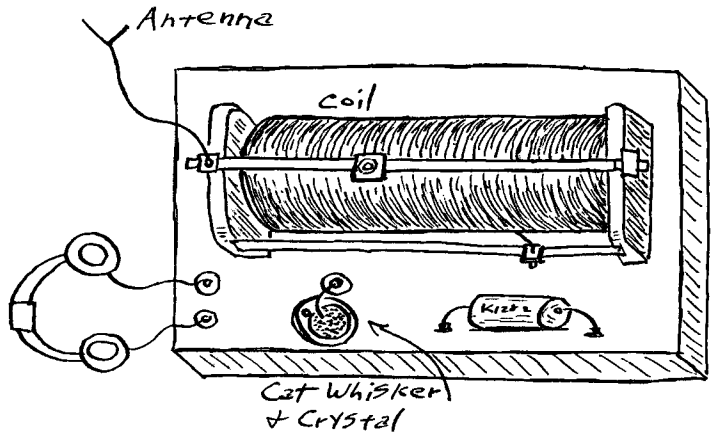
For three weeks the Boy spent each day trying to cajole his hawk into jumping or stepping to his outstretched fist for meat. The hawk would lean forward and partially spread its wings and crouch down like a sprinter ready to start off, then change its mind, straighten up on the perch and look past the young falconer in another direction.

One day on the third crouch the hawk flew, but instead of landing on the outstretched fist, it winged past the Boy and kept going until the long cord tied to the jessies brought it down with a crash to the ground. Finally the hawk turned and, with the peculiar half-walking, half-hopping gait of birds of prey, headed back to the bow perch. When it was almost to the perch, it changed its mind, flapped up from the ground and landed on the Boy's outstretched fist. At that moment the Boy became a falconer. As talons and glove met, his inherited memory was fulfilled. That first short flight had connected his being across centuries to falconer ancestors. For his triumph, he named the hawk Caesar.

The time had come to fly Caesar free, but the boy had terrible visions of the bird flying off over the tree tops never to return. But it did not happen and he had believed it would not happen. There seemed to be an imperceptible bond between bird and boy—a sort of resonance as though they were connected to one another by some invisible tie.

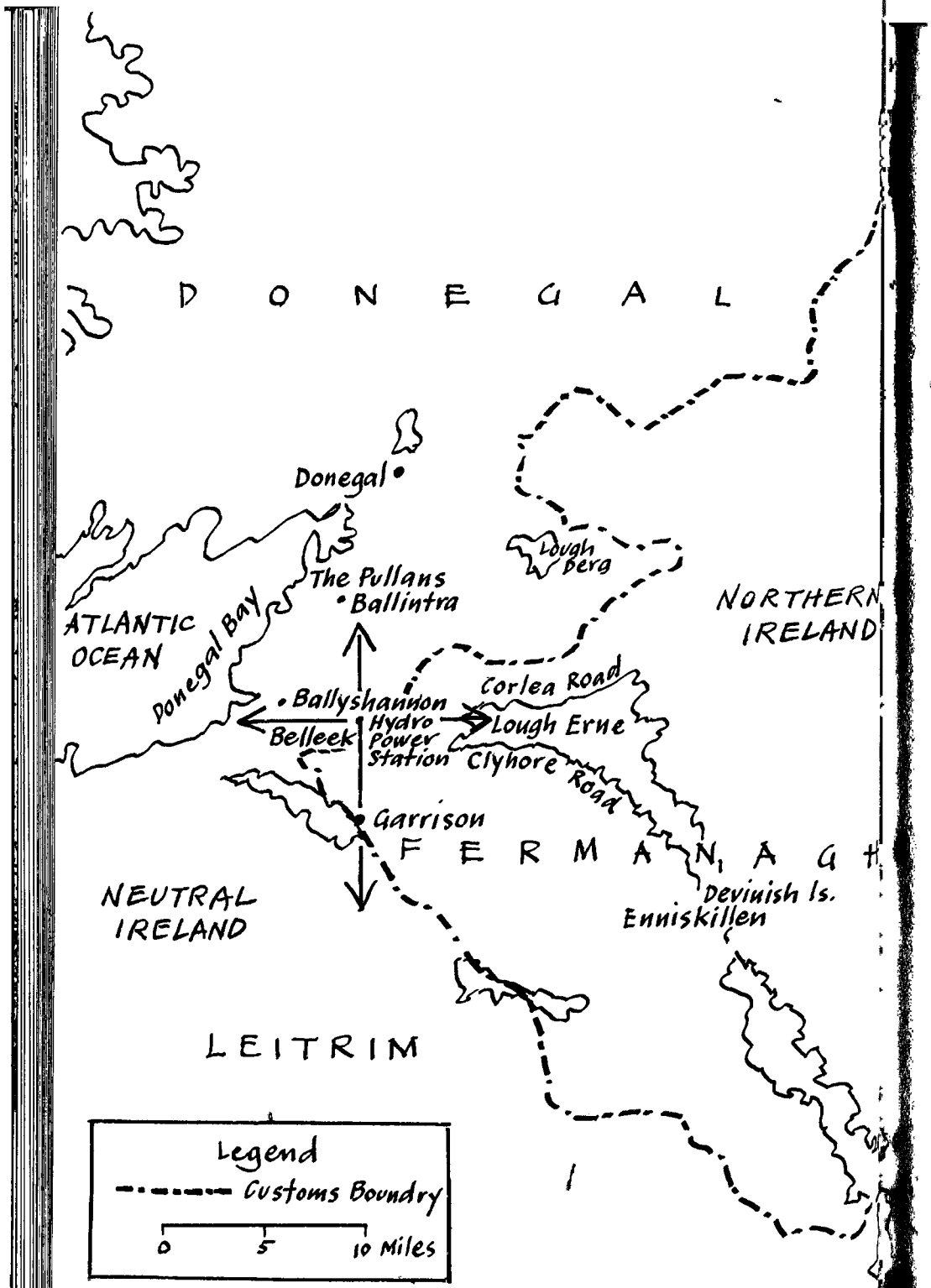
The Boy wondered if it were the same as the resonance that worked the crystal radio receiver he had built. He had seen the plans for the set in his old *Boy Scout Handbook*. In the basement of his house on Menands Road he built the set and, when he was ready to test it, he connected the tuning coil to the springs of his bed. The springs would serve as the

antenna to pick up and collect the mysterious radio waves out of the air. The *Boy Scout Handbook* said it should be a great moment as the music and voices came over the Boy's headset. It was!



He had never heard of Nikola Tesla, who discovered resonance in radio waves. However, like Tesla, he had come to believe that all of nature was in harmony. In his heart and in the deep recesses of his mind, he believed that it must be the mysterious phenomenon of resonance that connected all living creatures one to another, but especially the Boy to his hawk.

Part II The Soldier



Chapter 3

The Battle of the Beams

> *At the same time, however, we gave orders to the RAF Coastal Command to dominate the outlets from the Mersey and Clyde and around Northern Ireland. Nothing must be spared from this task. It had supreme priority. The bombing of Germany took second place. All suitable machines, pilots, and materiel must be concentrated upon our counter-offensive, by fighters against the enemy bombers, and surface craft assisted by bombers against the U-boats in these narrow vital waters.*
>
> Winston Churchill—*Their Finest Hour*

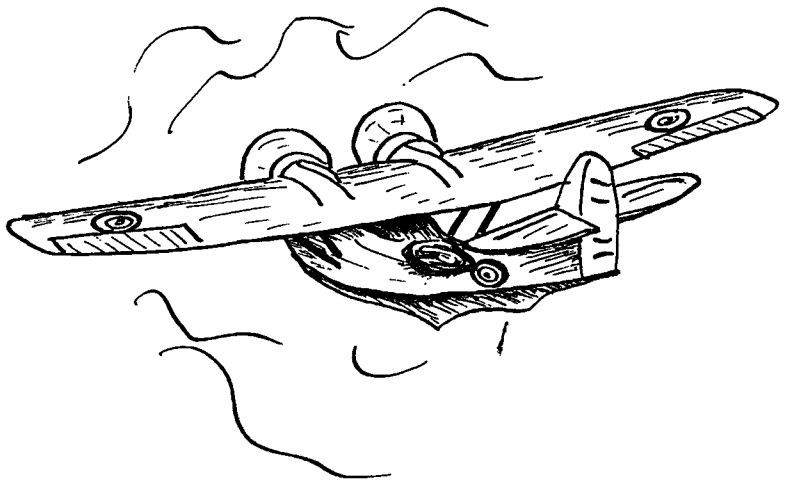
The Soldier stood in the doorway of the transmitter hut where he could hear the dull drone of the Coastal Command flying boats. They followed the River Erne on a sky path that led them to shelter on the quiet waters of Lough Erne. The graceful curved bellies and long wings of those sub sinkers gave them a form as graceful as that of the black-backed gulls that live on the Lough.

The Soldier liked to stand in the light of early dawn and watch the planes break out low above the turreted roof tops of Magheramena Castle.

On overcast days the lapwings wheeled beneath the darkening skies. Even through misty air the black and white of their graceful wings flashed against the sky to signal their landing approach. Like a squadron of Spitfires with lowered landing gears, they drifted as a single compact group onto the lawn of the castle.

Every morning as the lapwings settled down on the lawn to feed, a Catalina flying boat would break through the storm clouds to the west and like a lumbering albatross bank over the transmitter hut and follow the river across the few miles of land that lie between the Atlantic Ocean and the safety of Lough Erne. It was a dangerous ten-mile stretch of land for the aircraft had pushed its fuel to the limit. It was armed for submarine hunting across the North Atlantic. Overloaded with depth charges and bombs, there was no second chance if it missed the calm surface of the sheltered lough. Once in a while one of the sub hunters did miss and the bodies of the crew were carried across the Irish Free State border by an honor guard.

The Soldier had come to this little-known radio range station on the Irish border after we entered the war. Because of the war, his family had been scattered to the four corners of the globe. He was a part of what Winston Churchill would



later call the "Battle of the Beams." He and four other soldiers kept the radio station on the air. It was the act of a benevolent God that they all returned safely after the war.

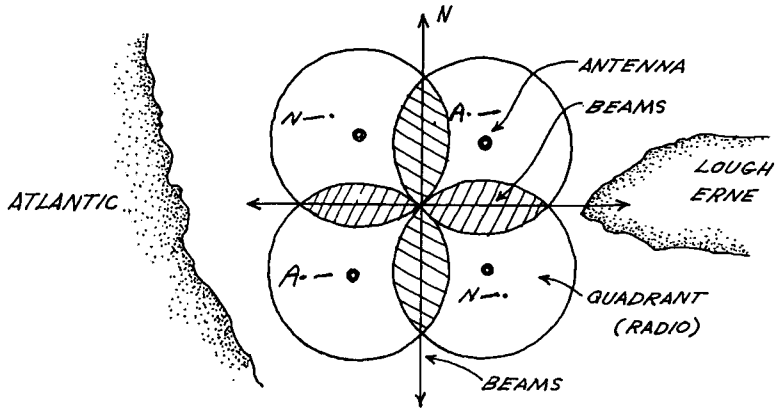
The transmitters sent a long homing beam out over Donegal Bay and the North Atlantic. It was used by the flying boats of Coastal Command to sink the German underwater predators. The location near the little town of Belleek on the border was not publicized lest the German fleet catch on.

The Soldier's war was a game of watching and waiting —not as exciting as the battlefield but just as deadly in a quiet sort of way. There was, of course, always the possibility that the station would become a battlefield. Presumably Ireland was safe, but not if the IRA or a German landing party from U-boats decided to blow up the station.

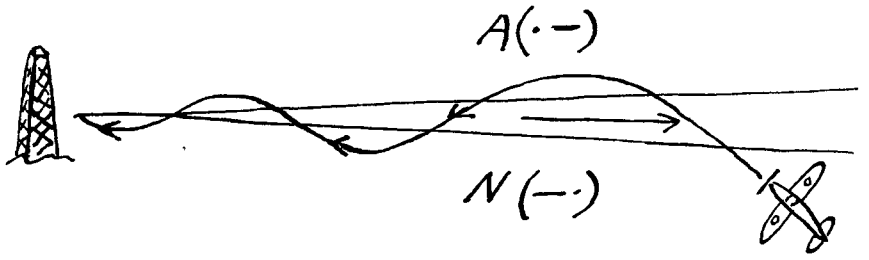
The radio range put out four beams at right angles to one another. The north beam lay across the Pullan, a vast and wild moorland that lay between the River Erne and the towns of Ballintra and Donegal to the north. At the edge of that great bogland the farmers of the district cut the turf that they burned in their great open fireplaces. From the high plateau of Magheramena Castle grounds the Soldier could see the turf carts pulled by donkeys or the rugged little mountain ponies with great wicker creels of turf hanging on either side.

The west beam from the transmitters lay out over Donegal Bay and the east beam down the center of Lough Erne. The south beam was not used for it lay over the neutral Free State.

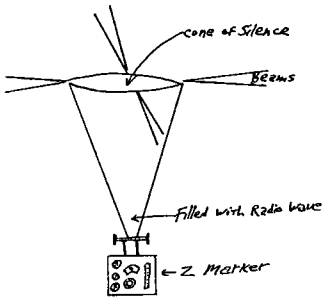
The electronic concept of the radio range station was simple. It consisted of four antennas set in a square. Each antenna put out a circular pattern. Two of the opposite towers put out an A (• —) in Morse code, the other two an N (— •).



Where the patterns overlapped, a steady tone (——) was formed from the interlocking A's and N's (· — — · · — — ·). The closer the pilot flew to the center, the more the A and N merged into a steady tone. A flying boat pilot out over the North Atlantic in an N (—— ·) pattern would turn and fly south until he hit the steady tone (beam). If he went too far south he would be in the A (· ——) quadrant and would turn back so that he ended up flying the beam in a gentle undulating pattern like this:



The station was identified by the call letters BK for Belleek and operated at a low frequency of 320 kilocycles. Directly over the transmitter there was an area called the "cone of silence" where no radio energy was given off.



A second transmitter at a higher radio frequency filled the cone of silence with radio energy that triggered a red light in the cockpit as the planes flew directly over the station. The center marker over the station was called a Z marker. It told the flying boat pilot that he would soon hit the east leg of the beam over the lake and should start his let-down along that leg.

No matter how stormy or foggy the North Atlantic, the sub sinkers could fly out overloaded with depth charges, sink their subs, and return safely to Lough Erne. Since the British High Command had broken the German super code called Enigma, they knew exactly where every German wolfpack was located. In three years the RAF Coastal Command systematically sank the entire German submarine fleet.

It was not radar that saved Britain from U-boats cutting her off from her American allies. Instead, Britain, as history truly records from the mouth of Winston Churchill, was saved by the *Battle of the Beams!*

Magheramena Castle Radio Range was such an important part of that Battle of the Beams that after the war the Belleek transmitter was mentioned by Churchill himself. The fact is he considered the U-boat war of the North Atlantic more important than the bombing war.

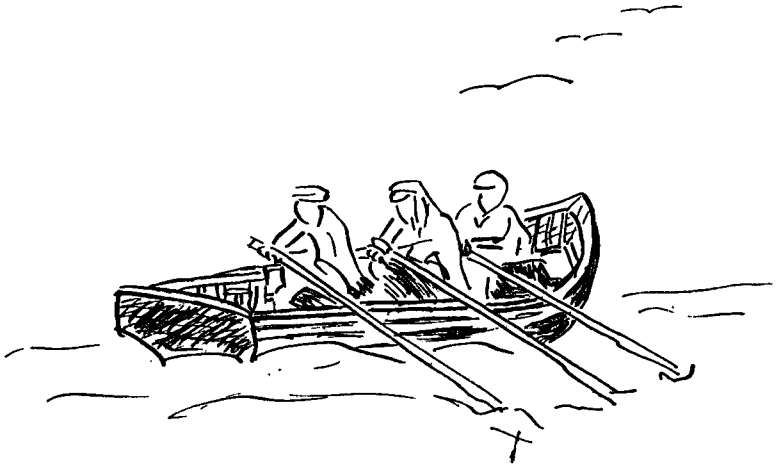
The soldiers at Magheramena knew their job. In three years the Belleek Radio Range Station, night or day, never logged so much as five minutes off the air.

When he was not on duty watch, the Soldier went birding across the Pullan moorland or searched for peregrine falcon nests on the rugged cliffs of Lough Erne or magpie nests among the beautiful forests of Glencar in County Sligo. Since Glencar and the Pullan were in neutral southern Ireland, he had to change to civilian clothes to cross the

border. On such hikes the only thing military he wore were his strong leather army boots.

He loved the thatched roof cottages that dotted the countryside. The mood of such cottages on a bright day was one of charm, brightness and color. It was inevitable that the cold gray clouds, that made Belleek Radio Range so necessary, and that blew from the North Atlantic, could change that mood to the other extreme. When the winds blew from the north they brought with them rain and cold fog. It rolled across moorlands and valley and shrouded the countryside in a monotonous dismal gray that consumed the color of the land as night consumes day. The gray often lasted for weeks and the firm dirt farmyards became slippery quagmires.

The farmers appeared in tall Wellington boots with their corduroy trousers tucked in at the tops. The eaves dripped water, the turf stacks, the bushes and the hedgerows dripped water, and the very character of the entire countryside changed from the brightness of an artist's palette to the grayness of a graveyard headstone. The often melancholy



and nostalgic literature and poetry of the Irish country people has been influenced by their changeable climate as indeed have their personalities.

On one such gray day the Soldier travelled to Enniskillen, and asked some Lough Erne fishermen to row him to Devenish Island.

Even on bright and sunny days Devenish, with its monastic ruins and tall, intact, round tower, is a strangely mysterious island. It is haunted by ghosts of its own Celtic past.

The fishermen left the Soldier alone on those quiet shores and he quickly became prey to his own deep thoughts. The lapping waters and a gentle mist surrounded his person. He was overwhelmed by a peculiar desire for a total "aloneness" and yet in his soul there was a most powerful love for companionship. He had the same feeling whenever he hiked across the lonely expanse of the Pullan moorland. The feeling was a mystic contradiction and he thought perhaps it was the real reason why Irish monks built their godly dwellings on island places—rather than for reasons of defense as some archeologists believe. The Soldier wondered if the average scientist ever had such feelings. He had deep sorrow for them because he suspected they did not. He wondered why it took a war to bring him to such a "feeling" place, and he wondered why he loved the distant drone of those deadly Catalina flying boats.

Chapter 4

Ghost Moth

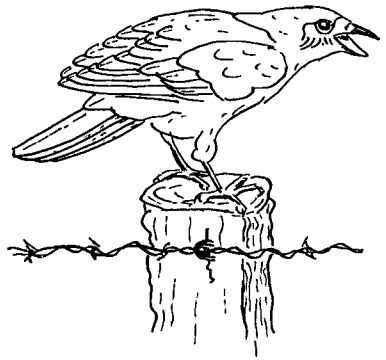
> *The behavior of this insect is remarkable. The male generally swings to and fro a few feet above the grass, making no progress but looking as if dangling at the end of a string. The flight begins at dusk and they constantly vanish and reappear as dark underside and white upperside are alternately exposed in the fading light by the movement of the wings.*
>
> E. B. Ford—*Moths*

The wild moorland plateau called the Pullan rises from the valley of the Erne and flows in gentle swells of purple heather across southern Donegal. In the very center is a rocky knob called Breezy Hill. From Ballyshannon, the town of the poet William Allingham, there are two roads into Northern Ireland. Both follow the winding banks of the Erne.

The south road called Clyhore is paved and lined with neat stone fences and tall clipped hedges, but passes uncomfortably close to Teetunny, the old haunted graveyard. The other road called Corlea was dirt and passed between huge beech trees before the hydroelectric scheme flooded the river road at Cliff. It curved past Corlea Hall where ceili dances were held on Sunday evenings.

There are no ghosts on Corlea road until one reaches the crooked bridge at the foot of the Pullan Brae—the latter being the steep hill road that leads to the small rocky bogland farms at the base of Breezy Hill. In the stretch between the crooked bridge and Pullan Brae one can bless oneself and presumably safely pass the supernatural beings that haunt that place.

When bicycling the stretch it helps to whistle loudly, but that was not a good protective stratagem for the Soldier on the road. He knew it would not be in his best interests to whistle along the Pullan Brae, for he had gone to a ceili in Ballyshannon and taken the Corlea road to escape the police and customs hut on the other road, and had no intention of alerting any southern Garda patrol that might be in the vicinity. He was in civilian clothes, an American soldier in a neutral country, and he did not wish to test Southern Ireland's neutrality—at least not just yet, discretion being the better part of valor even for a soldier. Besides, he did not want to mar that particular evening, for at the ceili he had met the beloved who would later be his wife. The Soldier was familiar with the whole expanse of the windswept Pullan, and with the valley of Erne as well. He had had plenty of time to explore when he was not on duty at the

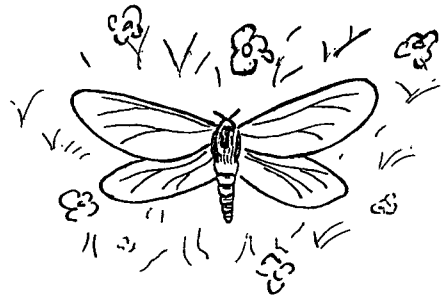


transmitters. And there were no lieutenants, those rigid-thinking administrators of military red tape, to program his time. Although in the army, he was, strangely enough, as free as the ravens whose ringing croaks echoed across the bogs. That part of Ireland did not have many species of birds, and the ones that did exist were often new to him, like the great black raven that nested on the rocky cliffs along Lough Erne. The country also had some odd species of insects.

The crooked bridge on that shadowy river road was a fitting place to spot the ghost moth. Of course, on that still spring evening he did not know it was a ghost moth or even why it was acting so peculiarly. He only knew that he forgot all about any Garda who might be on the road and dropped to his knees to watch the strange dancing creature.

The moth hovered over one spot on the grass alongside the crooked bridge. The top wings were pure white, the bottom ones a dark buff hue. It fluttered and danced over the spot as if it were tied by an invisible thread to an invisible skyhook.

As the twilight faded, the Soldier watched in fascination. He had seen this silvery white moth flitting along the hedgerows like a glowing apparition. It appeared and disappeared as mysteriously as the cuckoos in April and

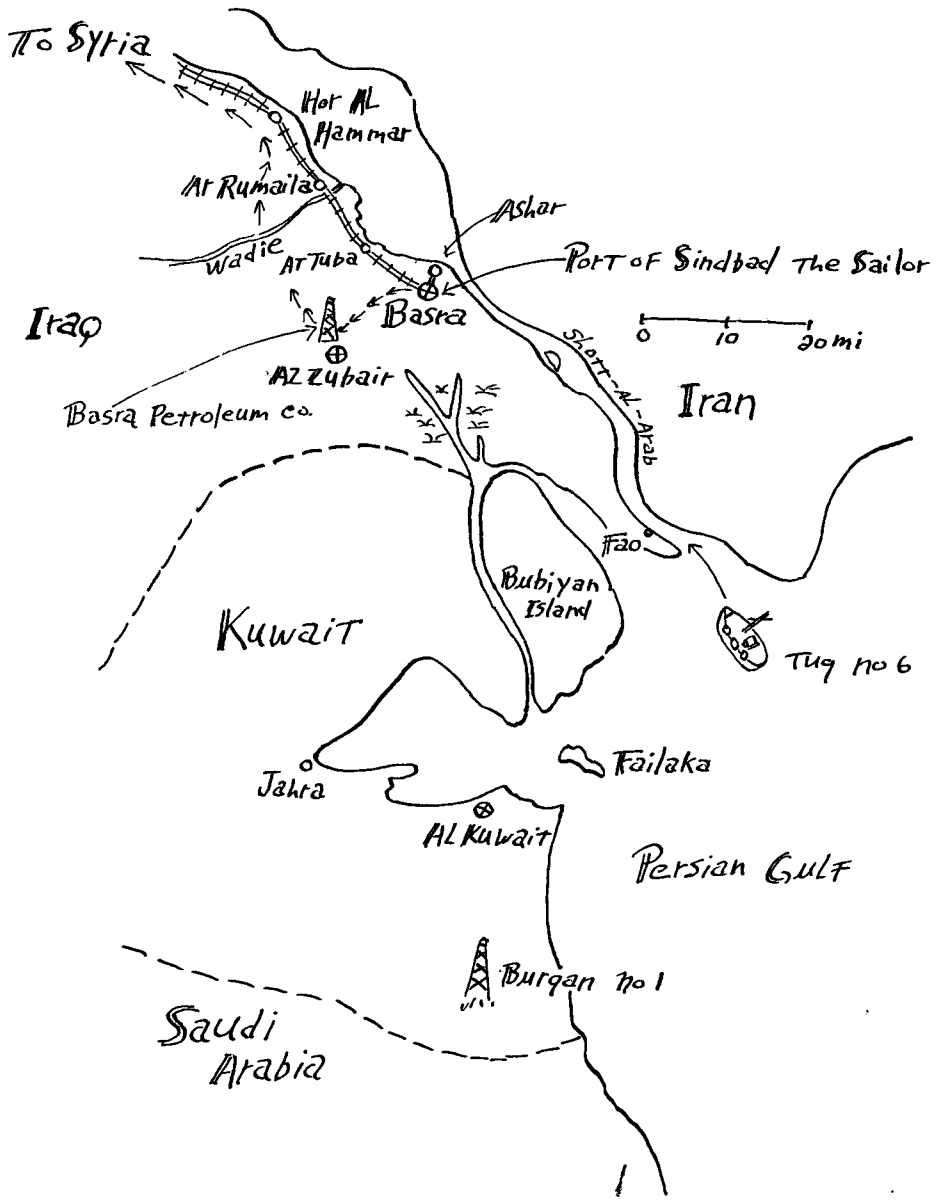


August. In flight, the white upper parts were highly conspicuous. When it dropped to the ground it folded its wings and hid among the grassy blades. The country people of Ireland have come to name it the ghost moth or ghost swift for its fast disappearing flight. The caterpillars, or larvae, of the moth feed on the roots of dandelion and stinging nettles.

The Soldier did not know this species, but in one of the old bookstores of Londonderry he found a copy of *The Butterflies and Moths of the Countryside* by F. Edwards Hulme. That beautiful book had a watercolor plate of "the ghost swift."

In one respect the moth was considerably different from all other moths the Soldier had observed. *Its antennas were extremely short.* The book said that the male ghost moth performed its aimless hovering flight over the spot where the dull colored female hides in the grass. When the Soldier read this he wondered how it was that the ghostly dancer knew there was a female hidden below. He kept such things stored in his memory in case he should meet this or similiar dancers again. He also wondered if the male were receiving a signal from the female like the Z marker signal above the radio range station. Was there a special feeling in the soul of the ghost moth as there was in his own soul that day he spent on Devenish Island?

Part III The Wanderer



Chapter 5

Trimmer

> *Now what has been a gentle rolling movement developed into a decided pitch. It upset his calculation with the barrow. Worse than that it caused him sometimes to tip the barrow over when it was nowhere near the chute. The blood was beginning to pound in his head with the physical effort of trimming the coal and supplying firemen—there must be about nine bloody firemen down there, all working like frigpots.*
> Sam McAughtry—*The Sinking of the Kenbane Head*

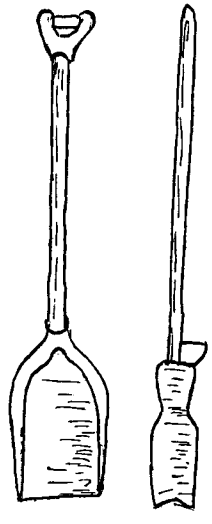
The great war ended and there were no more subs to sink. The Wanderer left Ireland and travelled to Japan and then overland across China and Siam to India. He signed aboard a seagoing tugboat in Bombay. They called him a trimmer, but he didn't work in a haberdashery—it was more like the Black Hole of Calcutta. He came up the hard steel ladder from the black hole and leaned over the railing. The sight of the butterflies and green-rolling, hot, shimmering Persian Gulf distracted his mind from his upside-down seasick stomach.

The flight of yellow and orange butterflies, beating against the gentle breeze, gradually drifted further and further out to sea. He wondered where the yellow blotches bouncing up and down against the shining sea were headed. Was some

beacon guiding them, or were they following a kind of "instinct radio range" through the air like the RAF Catalinas? Had a rebellious youthful call to adventure lured them away from the security of their land environment in the same manner as it had lured him to these hot desert lands? It takes a certain undefinable emotional elasticity to suddenly cut free from one's own kind and strike out alone into unknown worlds.

In his green-covered diary he had labeled this part of his journey "trimmer hell." At last he was off the day watch and had the cooler 12 to 4 early morning watch.

As the sun sank across the coast at Ras al Qaliya, he sighted the bright glow of the burned-off gas from Burgan No. 1 oil field in Kuwait. There was enough of deep earth's energy being burned away to power a thousand seagoing tugs like the one he had signed on. If his ship had used oil it would need no hot trimmer like himself to feed coal to the voracious burners. How strange that travel writers thought that shoveling coal on a sea trip was a glorious adventure —he had correctly labeled it hell in his diary. Those writers didn't even know that in steamships three or four firemen feed the furnaces but only one aching trimmer feeds the firemen from the black hole.



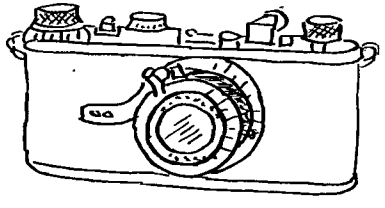
He would rather have cut turf from the bogs of Ireland where the curlews call than shovel coal into the rolling bowels of a tramp ship. On the bogs of Antrim and Donegal there are cool breezes and singing skylarks to ease the pangs of labor—in the trimmer's hole there was naught but blackness and skin-shriveling heat.

The Wanderer went ashore at Basra. The biblical Euphrates River valley lay ahead of him; but the Iraqi police arrested him, for they thought he was an American spy. He carried his little Leica camera around his neck. Even so, the great white jail on the road to Az Zubair on the outskirts of Basra was cooler and cleaner than the black hole on seagoing tug number 6.

The Wanderer was scared and sick, but kept his wits. He didn't curse or call the Iraqi police names; it was their land and he was a stranger. Instead, he spoke to the chief about Ur, birthplace of Abraham, of Kish, ruling city after the great flood, of Babylon, and of Tikrit, birthplace of Saladin, the great Arab leader and falconer. He spoke of joining nomads in the desert so he could learn their methods of falconry. He spoke to the chief of crossing the deserts of Iraq and Syria so that he could know those deserts as he knew the desert of Texas where his mother grew to womanhood. He told the chief that he thought the flight of a saker falcon must be at least as beautiful as that of the American prairie falcon.

The chief was fascinated by the Wanderer's stories of falconry. There must have been in his inherited memory threads from some long-ago Arab ancestor who hunted those hot deserts.

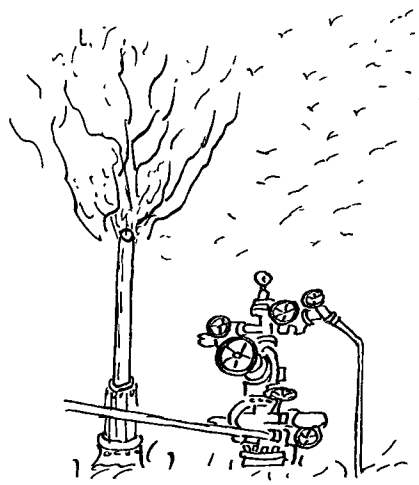
The Basra chief let the Wanderer go. He left his little Leica behind at the great white police station, but he still had his fountain pen and thick green diary and that was all he really needed to find out about the souls of the nomads who inhabited these biblical lands.



He also had the maps that he bought in the market place of Basra. Of all of mankind's inventions, the pen and paper are surely the greatest, for with these simple objects knowledge is spread to the four corners of the earth. The modern camera is but a child's toy compared to the mighty pen and tablet. However, the Wanderer thought that maps might be almost as great an invention as paper and pen.

Maps are one of the more delightful conceptions of the human mind. A map is both a painting and a piece of literature. The Wanderer had spread maps out on his desk at home, in village inns, on wind-blown sands of deserts and on the floors of rocky canyons, and even in the light of campfires deep in the forest swamps, but the anticipation of unfolding and using one of these pictorial representations of far-away places never failed to excite his imagination. With a map one can explore the world and never leave home.

He followed the road on his map along the canal to Az Zubair and past the Tower of the Camels dedicated to Zubair, friend of the Prophet Mohammed, who was killed in the Battle of the Camels. The tower is what remains of a massive minaret of the destroyed mosque. It serves as a daylight beacon across the desert, as do the fires of the more modern beacons of the Basra Petroleum Company during the night. Great flames of burning gas danced from the tips of those minarets.



The Wanderer hiked at night because it was cooler. The flames reminded him of what he had read in W. J. Holland's *Moth Book*. Holland wrote about the disappearance of the rosy Maple Moth which feeds on silver maple:

"The disappearance is due no doubt to the combined influence of the electric lights, which actually destroy millions of insects that are attracted to them, and the gas wells and furnaces, which lick up in their constantly burning flames other millions of insects."

He hiked on under the cover of darkness to the edge of the oil field and hid in the shadows lest they think him a real spy. The street lights of Menands were a mere flashlight compared to the powerful torches that lit the Iraqi sky from hundreds of burn-off pipes. Hydrocarbons combusted and burst into the cool desert air. Around the dancing flames swirled a herd of six-legged dancers the likes of which the Wanderer could not imagine. The ground was as deep in burned corpses as the gates of an Eastern village under attack by the Mogul, Jenghiz Khan. . . . Never had he seen such a variety of insects.

He scooped them from the ground and sorted out large moths and little moths, beetles and flies, and even wasps and bees that he had never seen gathered at street lights before.

Why light, he thought? Many of the deranged six-legged dancers did not fly to the flame but swirled about like mad whirling dervishes in the night air at the edge of the light. The huge moths with cross-armed antennas seemed to vibrate them in unison to the flickering light. Why do not insects fly to the sun and moon if visible light is the reason for such madness?

The sun rose red and pink across the Euphrates River and so he hiked to a wadi near the rail line at Ar Rumaila. He slept hidden in the shadow of the steep bank.

In his subconscious resided confusing thoughts about colored lights, camels, dancing madness and other inexplicable things. He did not sleep well but rather like a desert person filled with the mystery of life.

When he awoke late in the evening, he was sure he knew why the greatest of earthman's religions were born in the hot desert sands of the Middle East, but he wondered why the dance of the ghost moth in Ireland so resembled the dance of the doomed moths at Basra Petroleum Field No. 1.

Chapter 6

The Well

Life is the desert, life the solitude;
Death joins us to the great majority.
Edward Young—*The Revenge*

The Wanderer had a stamp in his passport for Egypt, but in Basra the fever had returned again, so that instead of going to the Syrian passport stamp-maker in that teeming city he had stayed in bed with his map trying to figure out how to cross the great desert of the Middle East.

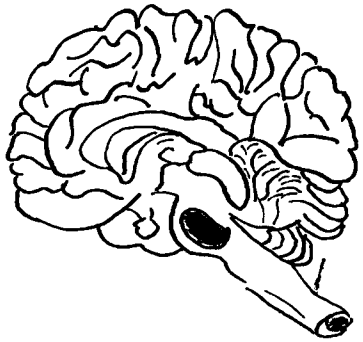
Mesopotamia is a strange and mystic land and the Wanderer's fever caused his mind to fade in and out as he hiked up the Great Euphrates valley in a dreamlike trance. At times the railroad tracks he was walking along rumbled like the long black escalator in Macy's Department Store. The rumbling was in his head. At the next village he caught a train so that the rumbling in his mind merged with the rumbling of the train and he could pretend that he really wasn't dying. He could not eat so he lay down in the train all day and night. He passed Ur and Al Hillah near Babylon, which he wanted to visit, and finally reached Baghdad. A big British lorry took him to Abū Kemāl where he crossed the Syrian border.

As he lay dying in the back of the truck (or so he thought),

a border guard soldier checked his American passport and then waved him on. The soldier did not seem to mind that there was no stamp, perhaps because the Wanderer had smiled at him. The smile is the greatest survival tool of humankind for it is a universal visa for "everyland."

In his walk in the sun, the Wanderer left behind many of his erroneous notions about faraway places; one was the "Lawrence of Arabia" concept of the Mid-Easterner. The Syrian villagers and Bedouins along the way were outgoing and courteous, perhaps because these people are visualizers. The Syrian soldier was obviously one because he did not seem to mind that there was no stamp. The Wanderer had learned from his walk in the sun that the world is peopled by two kinds—the left-brained "accountants" and the right-brained "visualizers." Today, the accountants operate the world with their so-called number logic and their incessant counting. They count bars of soap, toothpaste, cars, people and, of course, money, which they love to count most of all. As long as they count bars of soap and money, things are not too bad, but unfortunately many of them become desk bureaucrats and start counting people—and that is the end of any freedom to walk in the sun! *Das Kapital* is the bible for people-counters and the Russians love that book so they produce people-counters by the millions.

The right-brained people like the Wanderer—and the Syrian soldier—become the artists, writers and scientists of the world. It is said that right-brained visualizers depend on



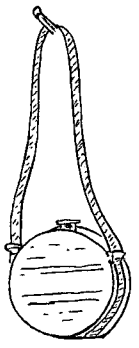
their emotions too much; but be that as it may, it is the visualizers who make life worth living.

There were not many people to count at Deir ez Zor. There was, however, a hundred-mile dirt trail called a track across the desert highland to Sukhne and Palmyra. The Wanderer knew that the Syrian desert is an extension of the great Arabian desert. It is a high plateau filled with ancient ruins and crumbling Crusaders' castles. The track from Deir ez Zor was nothing more than a faint line on the dusty plain. The only thing of note along the track was Qasr el Heir. That ghost of ancient days is believed to have been built to protect the trade that flowed between the Euphrates River valley and Palmyra.

The track to Qasr el Heir is almost invisible and loops northwards along the edge of the purple colored hills of the Jebel Bishri mountain range. The Wanderer had become uneasy in the early morning light for he thought he had misplaced the sandy track. All he could see was the dim outline of the northern hills. His head was now clear, but in his stomach there was the empty pit of fright. It hung there like a fire in his gut for he knew that even traveling at night, his quart canteen would only get him the twenty or so miles between the wells or village cisterns. At high temperatures (90° to 100° F), it takes at least one gallon of water to maintain water balance and that is with no walking at all! Walking at night, one quart would keep the Wanderer alive only three days at best. If he were to hike in the heat of the sun, it is likely that ten miles would be his maximum distance—John Wayne movies notwithstanding. Furthermore, one does not sip water but drinks as much as possible at one time. Sipping is wasteful as it does not saturate the cells of the body.*

*The physiological curve for water survival gives one 3 days of life for 1 quart of water at 100° F but only 5.5 days even if 10 whole quarts are available. Temperatures of from 90° to 100° F are not unusual in the Syrian desert and no person could carry 2 gallons very far.

The only logical solution for the Wanderer was to sleep by day at the wells, drinking as often as possible, and hike by night, gulping from his filled canteen.



There is no joy equal to the knowledge that one is on the "right track" and that joy flooded the very being of the Wanderer when he first sighted a campfire in the gray-red light of dawn. He was not lost in the desert for ahead of him lay the khan at Bir Jedid. The khans, or caravansaries, are rest houses scattered along the desert tracks. The arm of the Big Dipper pointing from the horizons to the North Star had not failed him.

He had a compass but at night it was easier to use the North Star. That fixed light never failed on clear desert nights.

It was November, the beginning of the cooler rainy season, and the safest time of the year for desert hiking. A good time for sleeping in the warm sun and walking in the desert night air which was invigorating and cold enough so that little water was needed to prevent body desiccation. The Wanderer had no desire to leave his bones bleaching in the hot sands, so he had practically memorized the little white Airforce Manual 64–5 that he carried in his pack. That compact paper book had taught him that in the desert a walk in the stars is better that a walk in the sun!

Because he was a visualizer, the history and culture of these desert lands lay spread along the neural pathways of his brain. He had even learned a few Arabic words, although a true visualizer does not need to learn languages, for such a person can see in his mind what a foreigner is saying by insight and nuance. The Wanderer's friends did not understand this and thought the Wanderer rather stupid for ignoring language. It would, however, be stupid for the

Wanderer to learn forty languages for forty peregrinations. Then his whole neural pathway would be cluttered and the left accountant side of his brain develop to the suppression of the right insight side. He would evolve into a cultural logic machine instead of a cultural insight person. He would count the stars and measure their light instead of watch the stars and measure their beauty.

Syria is the land where East and West are knotted together—the part of the world where ancient learning and scholarship were carried on camel backs from the Arab world to Europe and vice versa. The three wise men from the East are not a holy fable but a truism of historical continuity. Arab merchants and artisans roved back and forth across the Syrian plateau, and at Palmyra they came in contact with adventurous westerners and traded views on medicine, art, and the hunt. They flew their falcons together and compared the merits of the desert saker falcon with the peregrine. These were the desert visualizers and slowly their knowledge filtered out to the West.

The khan at Bir Jedid was in ruins but several dozen Bedouins in black and white burnooses were sitting about the well.

They moved aside as the Wanderer approached the wooden-covered hole. Many Syrian villages depend on vaulted cisterns for water, but this khan had been built at Bir Jedid for its underground source of that life-sustaining fluid. If the Wanderer had been able to see into the future, he would be surprised to know that thirty years later he would be the first man in history to demonstrate that ordinary water vapor emits narrow-band infrared radiation at room

temperature, and that water is to life as a laser beam is to a Bell Telephone communication system.

Scientists would learn to make water vapor lasers with mirrors by stimulating the vapor with huge pulses of electrical energy at high temperatures, but the Wanderer would stimulate emission by simply blowing the vapor through the air the way one breathes at room temperature. He accomplished this feat by simply adding a little ammonia, another chemical of life, to the vapor. Water is not only the carrier fluid of organic life, but also the "mission control" chemical of life!

The Wanderer knew nothing of this at the well, only that he desperately needed to fill his canteen and pour some of the magic fluid over his dusty body. Under the wooden cover of every desert well hangs a tin bucket but no rope. Rope is expensive and at a premium in those desert lands. Bedouins and village water girls all have their own rope. The Wanderer pulled from his rucksack a long nylon cord. That cord was, of course, as strong as a half-inch diameter hemp rope, but to those black and white figures surrounding the Wanderer it was a mere string!

Some of them were armed with old British rifles and as the Wanderer took the tin bucket from under the wooden cover and tied that thin white string to the handle, they fingered the triggers of those long weapons.

The Bedouins love the desert and live easily in it, but that way of life is unforgiving and to violate its rules means certain death. One rule is not to loose the bucket since roving nomads do not carry such implements away from their tent campsites. No bucket, no water for the tired Bedouins. As the Wanderer tied his knot, their smiles, that had been triggered by his cheerfulness, faded to frowns. He suddenly realized what was happening even though no words were passed. There are entire volumes on the theory and practice of survival, but they can all be boiled down into

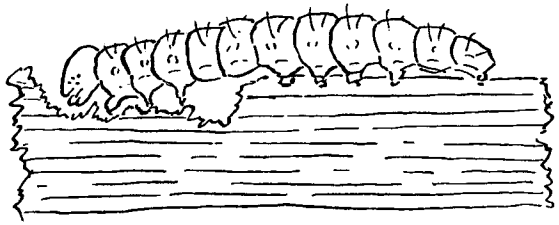
three words: *water, temperature* and *insight.* If one does not have water, one dies; if one is too hot or too cold, one dies; and if one is not a right-brained visualizer who understands the meaning of the magic word insight, one dies. A left-brained person would surely count the Arabs to determine if he could fight his way through them like John Wayne. His bones would bleach in the sun by the cool water of the well.

The Wanderer put the bucket on the ground and began a desert string dance. First he wrapped the string around each hand and jerked until the nylon cut into his flesh. He tied it between the khan wall and a post and like a crazy circus acrobat jumped up and down on the thin white cord. The sounds from the group were no longer murmurs of anger, but instead the ripple of astonishment. The Wanderer tied the cord to the bucket for a second time and lowered it into the well. As he pulled the precious liquid to the surface and poured it over his head, the desert dwellers gathered around and the aura of their friendly beings filled the warm air surrounding the well.

The Wanderer cut his nylon cord in half and gave the cut length to their leader. They in turn shared their lunch of raw kibbeh with him. He slept the long day at the well with his new friends. As he left they gave him a bag of burghul for his journey—a sign of true friendship and hospitality for food is scarce in the desert far from camel and goat encampments.

The Wanderer walked northeastward toward Qasr el Heir. There are two castles there and he could see the morning sun glinting off their white limestone towers. He reached the desert city at dawn and camped inside the walls of the courtyard. All was in ruins, desecrated by the human scavengers that search for ancient treasures in lost cities such as Qasr el Heir.

Here and there along the Deir ez Zor track, the Wanderer would take off his undershirt, not to absorb the sun, for that



is deadly in the desert, but to tie a knot at its neck and make an insect sweep net. Holding the bottom open, he could sweep it back and forth across weeds and grass and collect small insects in the improvised net. He boiled their tiny bodies over the campfire and mixed the protein goo with his grain burghul. The mixture of insects and grain, though not particularly tasty, fed the cells of his body better than the more tasty food in any cafe. Insect protein has every trace element and vitamin needed for survival, and one is indeed a fool to tempt fate by eating forest or desert plants that are unfamiliar.

The walk in the stars and the healthy food had turned the Wanderer into a happy being. The hot humid valley of the Euphrates was far behind and only the uplands between Palmyra and Homs lay ahead. The Wanderer had spent many days in the desert and wished to meet his friend in Ireland for Christmas, so instead of following the desert highlands to Homs he cut south to the Palmyra highway where he caught a ride in another sputtering truck.

As he lay on his back and gazed at the sky, his thoughts were of an ancient people who had learned to survive in a harsh land because they were visionaries who could see in the deepest chambers of their minds what it means to violate the organic rules of life.

They wear heavy, loose clothes to preserve their precious body water and eat grain burghul and goat meat to feed their flesh. They know where every drop of water surfaces in the desert, but most important, they are the right-brained

people who utilize insight to carry them through life. The Wanderer thought that perhaps the accountants of the West could learn a little from the desert people.

As the Wanderer headed for Egypt and Greece, he knew exactly what he had learned, which is that only visionaries can save mankind and that whatever lay in his future he would fight to the finish for his own visions, for that is what his day at the well of Bir Jedid had been all about.

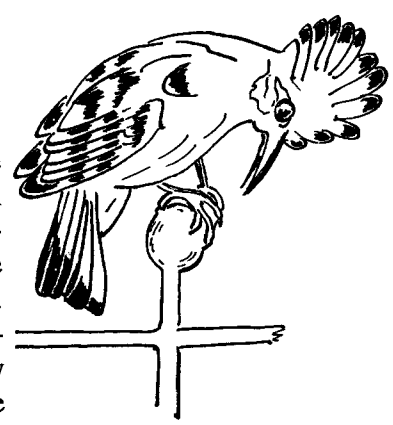
Chapter 7

Light at the Door

In the sun, it was believed, light was created when molecules were vibrated by heat. Tesla sought to improve on this method by vibrating the molecules by electric forces.
John O'Neill—*Prodigal Genius*

The Wanderer joined his two friends in London. One of his friends had taken the inland road from Edinburgh, one the middle road, and he had taken the coast road. In London they joked about the high and low roads from Scotland and because they liked one another decided to travel to Italy together. In Naples they signed on the *Maria C* bound for Algeria and Philadelphia. The Wanderer made sure that the job was as deck hand where he could work in the sea breezes and not as trimmer down below.

That was a wise decision for half-way across the Mediterranean Sea a hoopoo came aboard. It must have been a tired hoopoo from fighting the stiff winds that blew across the sea. The hoopoo stayed aboard for three days until the Italian cook caught the poor fawn-colored bird and ate it.



Of course, the bird was still on board but in the cook's stomach. The Wanderer was sad about the fate of the hoopoo—not only because the strange bird taught him something new, but also because it was just about the silliest bird God ever created. Divine Intellect most certainly was having a good day when He thought up the hoopoo.

The Wanderer and his two friends spent most of the day either painting or chipping paint or just plain loafing. It was not like being a trimmer and there was plenty of time to watch the sea birds overhead.

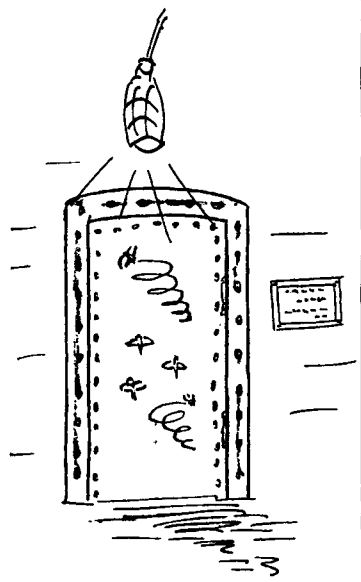
He was surprised to see the hoopoo fly aboard and perch on the knob of a metal railing. He had thought the hoopoo was a bird of Asia and had first seen one in the garden of the Taj Mahal in India. The exotic creature seemed to have evolved primarily to grace those ethereal gardens but here was one on the rail of this old Italian tramp.

The fawn-colored bird with the ridiculous scientific name of *Upupa epops* called a soft musical hoo-po-po several times and flew off in an undulating manner to the topmost yardarm.

Every evening the Wanderer went up on deck to stretch out on the canvas hatch cover and read. When twilight came, the lights by the bulkhead doors were switched on. The bulkhead door that led to the galley area under the bridge was close to the forward hatch and so he could sit and read in the cool night breezes and once in a while look up at the twinkling lights of other ships passing in the night.

On one such pleasant April evening he was surprised to

see insects swarming beneath the light over the door. The light was of a type typical of shipboard lamps—a clear glass shield on the inside of a heavy cross-barred protective grid.



Now the hoopoo must have been quite hungry since he had been flying so far out to sea. Suddenly he flew from the high yardarm where he had been perched in darkness and grabbed a moth from the deck in front of the lit-up bulkhead door. The bird was totally oblivious of the reader on the hatch and was darting and diving with considerable agility. He snapped the demented insects from off the door as fast as he could swallow them. At times he was so quick he was able to grab two at a time. Every once in a while the hoopoo would miss and smack into the heavy bulkhead door. The hard jolt never deterred the bird and he kept on filling his empty stomach.

The Wanderer was so busy watching the bird that he didn't notice the behavior of the insects, and the hoopoo was so busy grabbing insects that he didn't notice the Wanderer.

What a pleasant evening that was—the beautiful, silly hoopoo, the insects at the light, the passing ships in the night, the bow of his own tramp slapping the calm waters, and a good book about Jenghiz Khan by Harold Lamb. Not many are privileged to have such a night; such joys are a rarity. As with all such experiences, however, those hours could not be repeated—but if they could not be repeated, they could also not be forgotten.

Of course, the Wanderer tried to repeat, but when he went to the bulkhead door the next night there was no bird.

It was his friends, while they were playing "battleship" in their cabin, who later told him that the cook had caught the bird at the door and eaten it for his evening meal.

As the Wanderer sat waiting for the hoopoo to appear again, not knowing of its sad demise, he began to observe the insects more carefully.

Beside moths there were quite a few beetles that apparently took to the seafaring way of life. What he noticed, however, was that the moths and beetles were not going to the light at all. Instead, they were going to the bulkhead door under the light. That, of course, was why the silly hoopoo kept crashing into the door. There were numerous lit-up doors on the deck of the old tramp so the Wanderer went all around the deck to see if there were insects at any of the other lit-up doors. There weren't! There were a few at each door, but not hundreds such as were at the door which he called the "hoopoo door."

Now the Wanderer wasn't a scientist. What he really was, one might surmise, was a 1940-style hippy, but since he wasn't inclined toward smoking or taking drugs, although they were easy to get in the Far and Middle East where he had been, his brain wasn't fuzzy. Nor was he a specialist, so he was still capable of using reason and logic rather than isolated experimentation to deduce things. Since the deck crew, including himself, had painted that bulkhead the day before, the only thing different between the lit-up "hoopoo door" and all other doors was *fresh paint.* The paint had barely dried on the door and he could smell it from half a dozen feet away. The paint was of no special color, only the usual dull gray, as were all bulkhead doors on that deck.

He watched the insects closely; beetles and moths behaved similarly. They flew around in capricious circles under the light and eventually settled on the door. They crawled hither and thither over the rough metal, vibrating their antennas against its surface. The Wanderer didn't believe

that the metal or paint would be particularly appetizing even to an insect, but he did notice that the paint had the faint smell of bananas that was characteristic of his mother's fingernail polish.

Holland in his *Moth Book* described how night-flying moths are attracted to fermenting bananas. The old gentleman would make a concoction of beer and bananas and paint it on deep forest trees. After a day or so the mixture would ferment and he would go at night to collect the large underwing moths from the tree trunks. His book has a delightful essay on "sugaring" for moths, as he called it.

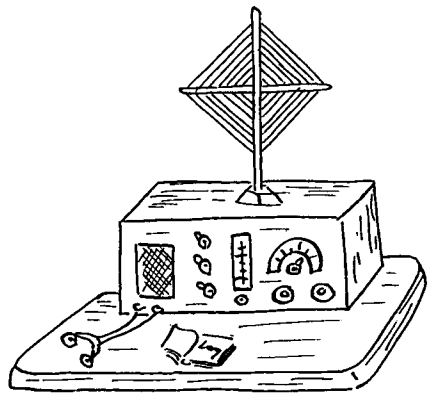
There was one other peculiar aspect of that "hoopoo door" and that was the simple fact that the entire bulkhead had been painted, not just the door alone; yet there were no insects on the rest of the painted bulkhead—only on the part under the light. The light did not appear to be 60 cycles but some lesser AC frequency for there was a faint visible flicker to it. The AC generators apparently put out 50 or so instead of 60 cycles. The human eye is able to detect 50 cycles, but 60 is too fast a flicker to see.

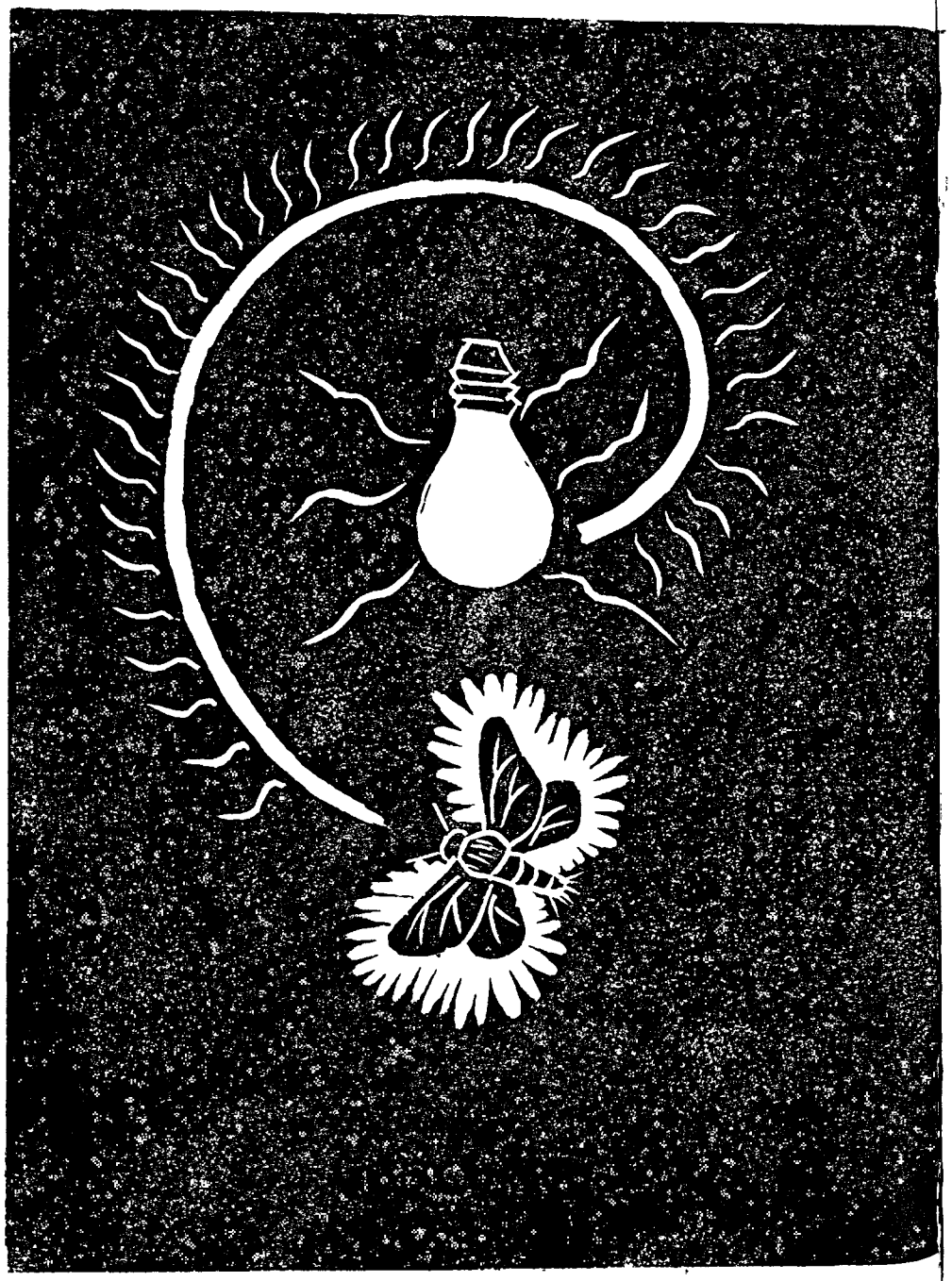
The Wanderer took the globe off the electric light bulb to see if any insects had found their way inside. A very few had, but not as many as he usually found in the porch lights that his mother asked him to clean out when he lived in Denver and Menands as a boy. He decided that it must be the banana paint scent from the door that attracted the insects. If the eye were involved why did they not go to the other door lights on the ship? All of the ships lights flickered and put out the same visible energy. Perhaps, he thought, the 50-cycle light heated the door and caused the scent molecules to oscillate like little infrared transmitters. After all, that is the way the sun was supposed to work and a light bulb was a low energy sun and the paint smell a gas! The Wanderer mulled these thoughts over in his mind but finally decided the whole episode was beyond his comprehension at

that time. He knew, however, that the attractant force required both the scent from the paint and the flickering light to work. He also knew that, whatever the energy was, the moths were resonating to it with vibrating antennas and not with their eyes as most entomologists would maintain.

The Wanderer decided to go to the radio shack and talk with the radio officer about communications. He didn't believe that "Sparky" would know anything about insect antenna systems, but he did know that it helped to talk to these old shipboard radio hands because they had a lot of experience with the phenomenon of resonance. They had sympathy for his ideas because they knew the power of resonance. They used it constantly to save lives and navigate in the vast expanse of the oceans. They didn't laugh when he told them what he thought about communication in nature —that at short infrared wavelengths it worked exactly like the ship's radio receiver.

The silly hoopoo had caused him to think deeply about the seaborne insects and the great flight of moths to Basra Petroleum Field No. 1. He would always believe it was the hoopoo that led him to question the belief that insects were attracted to light or hydrocarbon fires because of the visible light alone. The light at the door was an important turning point in his life and he hoped in his heart that hoopoos would never become extinct like passenger pigeons or ivory-billed woodpeckers.





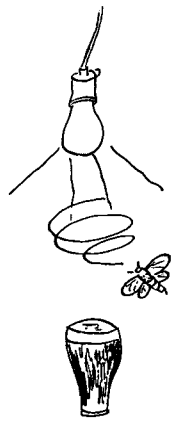
Part IV The Entomologist

Chapter 8

Westport

My blood flows fresh, my soul finds food,
I roam the world at large,
And nature, smiles she not most good
Who holds my heart in charge!
Goethe—*Auf dem See*

The Entomologist hiked down from Croagh Patrick, the sacred mountain of Ireland. He drove to Westport and stopped at the pub to refresh his spirits. He stayed late into the evening and, as the Guinness flowed, an Irishman of local origin, with a fine tenor voice, entertained the happy customers. Directly above the Gaelic singer's head a lone light bulb shone down on the black-colored pint of stout on the bar. Half-way through his melancholy lament a small moth flew to a position directly above and half-way between the pint of Guinness and the bottom of the light bulb. Now if a moth spirals to a light bulb, instead of dancing to some unknown invisible force, then surely the Irish moth should have continued upwards to the light above.



Since it was close to the singing Irishman's nose, it soon became an annoyance. Time after time his hand shot up to grab the irritant. However, Guinness does not contribute to one's equilibrium, so each time the little moth dodged aside. For fifteen minutes the moth held its circular flight positioned above the pint. This in spite of the best efforts of the balladeer.

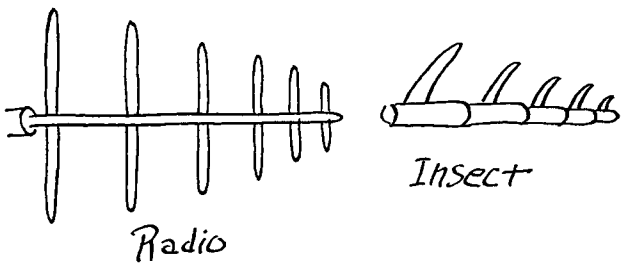
Eventually the moth flew to the ceiling and settled in a crack. It never approached the hanging light bulb. Like the wavering ghost moth of the Pullan Brae from so many, many years before, it was held by an invisible force at a precise altitude between the light bulb and the alcohol. There was, however, one major difference in the Entomologist's mind between this dancing moth and that of the Pullan Brae. This time he knew exactly what the invisible force was!

When the Entomologist returned home after so many years of wandering, he went to college. He studied about ships, and kings and cabbages and finally won the right to be called a philosopher. Of course, he had always been a philosopher but the degrees made it legal.

Somewhere along the course of studies he began to look closely at the antennas of his vibrating moths. He had a difficult time for the scanning electron microscope had not been invented yet and he had to use an old microscope that the college professor bought for him. He soon discovered that he could see the little spines on the antenna by reflecting bright visible light off them. With a scanning scope, he could have described the antenna of the corn earworm moth in fifteen days, but it took him fifteen years

with the bright visible light and the professor's microscope.

He discovered, as he believed he would, that the tiny spines were arranged along the length of the tiny antenna just as the bars of certain radio antenna are arranged along the metal bar that supports them—short and close together spines at the tip, and long, far apart spines at the base like this:



The electrical engineering college professors call such an antenna a log-periodic array and gave formulas for determining how to design such a system. Of course the Entomologist did not have to design a log-periodic array since God had already done so and placed it on the corn earworm and cabbage looper moths.

To understand the significance of these tiny spines, and their relationship to radio antenna, it is necessary to know a little about the electromagnetic spectrum. We all live in a "sea" of radiation, much of it invisible to us. The sun, the moon, light bulbs, radio transmitters, plants, the human skin and even the night sky all give off radiation of varying wavelengths. Because such radiations have both an electric and magnetic field, they are called electromagnetic.

The electromagnetic spectrum is, in a sense, a measurement of the varying wavelengths of radiation. On the one end, we have the extremely long wavelengths of radio which are yards or miles long; on the other end, the extremely short ultraviolet (UV) wavelengths which are measured in micrometers and which can be detected by the eyes of

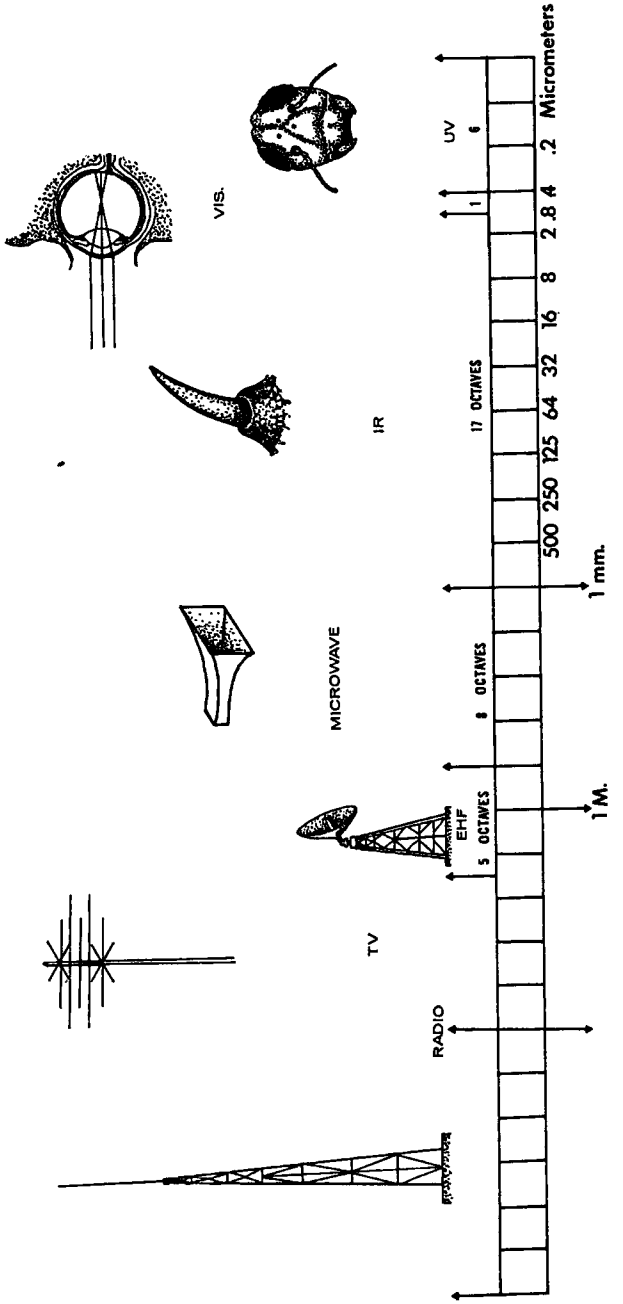


Figure 1. The electromagnetic spectrum stretches from radio wavelengths *(left)* that are yards or miles long through the extremely short waves of ultraviolet *(right)*. Past ultraviolet on the right are X-rays and high energy beta and gamma rays. Above each region of wavelengths in this spectrum are shown the collectors (antennas) for the region. At radio and TV wavelengths we can use metal *bars* cut to the proper lengths to match the radio wavelengths. At extremely high frequency (EHF) radio and microwaves, we utilize *dish* and *horn* antennas. The insect utilizes *spines* in the IR region and the human eye a *lens* and *rods* and *cones*. Insects utilize lenses in their compound (multiple lens) eyes to "see" ultraviolet light.

insects. A micrometer is 1/1,000 of a millimeter long.

The radio band of the spectrum includes the long wavelengths of broadcast radio, the shorter wavelengths of TV, and the extremely high frequency (EHF) wavelengths of radar. All frequencies shorter than 1 meter long (100 centimeters) down to 1 millimeter long are called microwave frequencies. High resolution radar and guidance systems operate in this region. From 1 millimeter down to 0.7 micrometers (red), where human eyes see, is the infrared (IR) portion of the spectrum. This almost unexplored region of the spectrum contains 17 octaves of radiation and is the largest region.

Still further down is the UV region of the spectrum. Human beings cannot see beyond 0.4 micrometers, but insects see into ultraviolet to slightly below 0.36 micrometers. Insect spines, which operate in the IR region, represent the transition between the long metal bars and horn antennas that collect and guide radio and microwave frequencies, and the short insulative (substances like glass) lenses that collect and guide visible and UV wavelengths. A lens may be thought of as a foreshortened and rounded antenna. In the IR portion of the spectrum, the study of antenna engineering and the physics of optics overlap, and the techniques and mathematics of both must be utilized.

The Entomologist had enjoyed going to college because he took courses he liked, such as bird watching and political science, since he had traveled a lot; and literature and history because he thought those courses beautiful. He even enjoyed dissecting dead cats and insects because he was head over heels in love with the form of living things.

Although he didn't take courses like computer science or the mathematics of designing radios because he had found out that such courses put him to sleep, he took so many different courses that the dean asked him if he wanted a BA or BS. He took a BA because it sounded more poetic.

He was happy that he enjoyed college and his graduate studies because he soon found out that he didn't need those "put to sleep" type courses. Anyone who can divide and multiply and take square root could understand all the big thick books on antenna and waveguide design. Some of the formulas for antenna arrays looked like this:

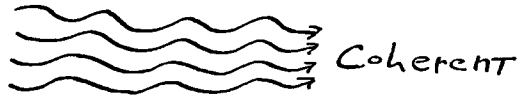
$$\frac{E_e}{E_{max}} = \frac{(K-1)\sin\frac{\pi L}{\lambda_0}(K-\cos\theta)}{(K-\cos\theta)\sin\frac{\pi L}{\lambda_0}(K-1)}$$

which seems very complex but isn't. Once the Entomologist learned what all the little squiggles meant, such as E for the electric field around the antenna, and L for length, and λ for wavelength, and K for the wavelength in free space after it has been divided by the wavelength traveling on the surface of the little spines, and θ for an angle the cosine of which can be found in a table, then all he had to do was divide, multiply, etc., etc., to get the answer. It wasn't nearly as complicated as it looked but the professors liked to think it was for it made them feel very important.

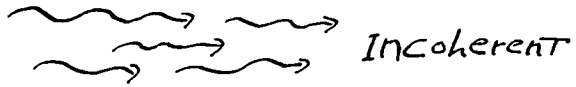
The Entomologist soon found that when he used all the formulas in the big thick book, his answers always indicated that the tiny little spines ought to resonate in the infrared portion of the spectrum.

However, the mathematics that told him his moths were flying around tuned to infrared radiation presented one huge problem. The professors assured him that absolutely everybody knew without a shadow of a doubt that in order for the spines to collect infrared radiation the wavelengths would have to be coherent. That is, they would all have to be going

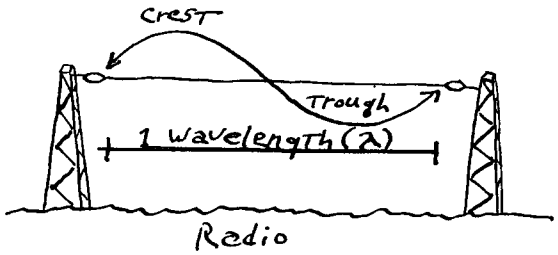
out from the transmitter together something like this:

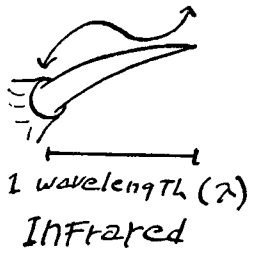


and not separately like this:



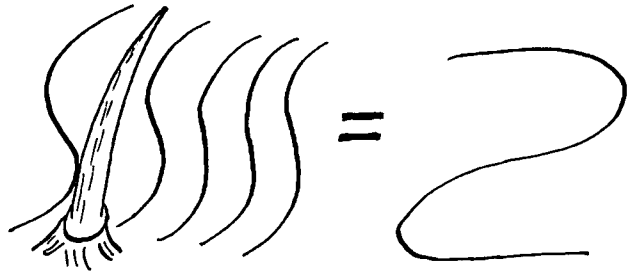
because that is how radio antennas collect only coherent radio waves, since the antennas are cut equal to the length of each wave to include one trough and one crest like this:*





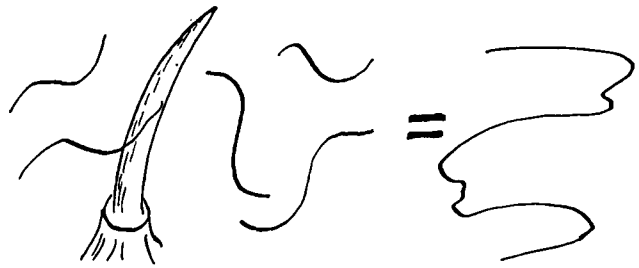
*Radio antennas are usually cut to ½ to ¼ wavelength in order to shorten the antenna wire length. Dielectric antenna, however, resonate to extremely short millimeter and micrometer (IR) wavelengths and have been shown experimentally to work best if they are constructed from 1 to 6 wavelengths long. I have simplified my drawings to show both systems as being 1 wavelength long.

Even the Entomologist could plainly see that if all the infrared waves were going out incoherently, as they did from a heated body, then the spines could not "tune" or resonate to them any more than a radio receiver antenna could resonate to radio waves that were not moving together. He could also see that if the radio or infrared waves were all together they would add up like this:



and make a very big wave that radio engineers call a high amplitude wave.

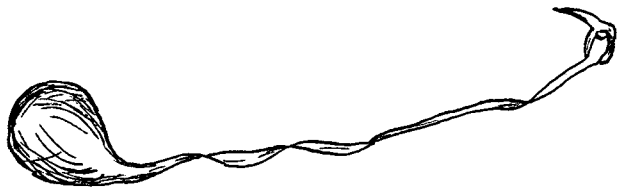
If they went out incoherently they would not add up and could not be collected by the little spines because they would all be lopsided like this:



The professors all decided that the Entomologist should not have such a radical idea as saying that an insect antenna

really was a radio antenna, even though there were a few electrical engineers who agreed with him—one in far off Australia,* one in London, and one in the state of New Jersey.

Since he wasn't allowed to publish his radical ideas, he worked on the behavior and morphology of his night-flying moths. He described how the male moth leaves a sperm sack, called by entomologists a spermatophore, in the female reproductive tract,



and how the male and female copulate. He counted the spermatophores, which seldom disintegrated in the female, to tell how many times one had mated.

The Entomologist considered it very nice that God had designed the night-flying moths in such a way because it made it easy to see if his mating experiment had been successful. Soon entomologists all over the world were using the technique of counting spermatophores to study reproduction in all kinds of insects and the Entomologist became known as an expert in the sex life of moths.

He described how moths fly, and when they fly at night. He discovered that his moth had a higher chance of mating if he used low intensity blue light in his cages and if the humidity was between 55 to 70 percent. He spent his time studying as many of the ecological factors as he could study that contributed to high moth reproduction. Over those many happy years the Entomologist spent long hours

*G. R. M. Grant

observing the sex life of the little creatures in a screen insectory set among the redbud and dogwood of a hillside forest at the university.

Many years later, after he had completed all of the ecological and behavioral studies, he rewrote his infrared-antenna spine paper and sent it to an optical journal that had an editor with a very open mind for new ideas. It is customary for scientific editors to be bound by a silly system called "anonymous peer review." Editors therefore work under very hazardous conditions where new ideas are concerned. It is a very simple truism that if a scientist (or garbage collector) does have a new idea he has no peer —otherwise it is not a new idea!

The Entomologist was beset by anonymous nonpeers and since they were anonymous he could not even argue with them. No matter what he wrote, they either didn't understand, or if they did, they threw his infrared papers out because they didn't agree with what the entomology text said.

The Entomologist didn't pay much attention to these nonpeers because they weren't really interested in resonance anyway and they certainly didn't believe that coherent radiation came from anything in nature. After all man had invented both radio and coherent lasers and one couldn't possibly suspect that nature could have preceded man by billions of years! The physiologists especially ignored the Entomologist because in their narrow world the nerve impulse was the answer to everything electric. The beautiful shape and arrangement of the spines did not mean a thing to those scientists—only the nerve ending was important.

Since the chemists and physiologists were certain that the Entomologist was wrong, their intolerance spread to most of the well-known biological journals, so the Entomologist sent his papers to physical journals which, in some ways, was unfortunate because biologists never read the physical

journals. The world of science has become filled with narrow specialists.

The Entomologist believed excessive specialization didn't lead to breakthroughs in science, so he kept right on reading books and journals in all the sciences. It helped him to cross-correlate data from many different disciplines and he soon evolved a feeling for the complexity of natural systems.

He ignored his so-called peers, not because they might be right or wrong about his work, but because they invariably demonstrated that they confined their reading to very narrow disciplines. They had what his friend the electrical engineering professor called tunnel vision.

Apparently such researchers never sit in a desert at night watching fire-lured moths, or shovel coal on a sea-going tug, or watch a moth dancing above a pint of Guinness in a Westport pub. But, worst of all, none of them ever, ever seemed to worry whether or not the insect-eating hoopoo might become extinct from eating DDT'ed insects, much less that bird-eating hawks might might become extinct from eating DDT'ed hoopoos. The Entomologist did not even want to think there might not be any more hawks like Caesar in Witche's Woods.

Chapter 9

The Hour of the Wolf

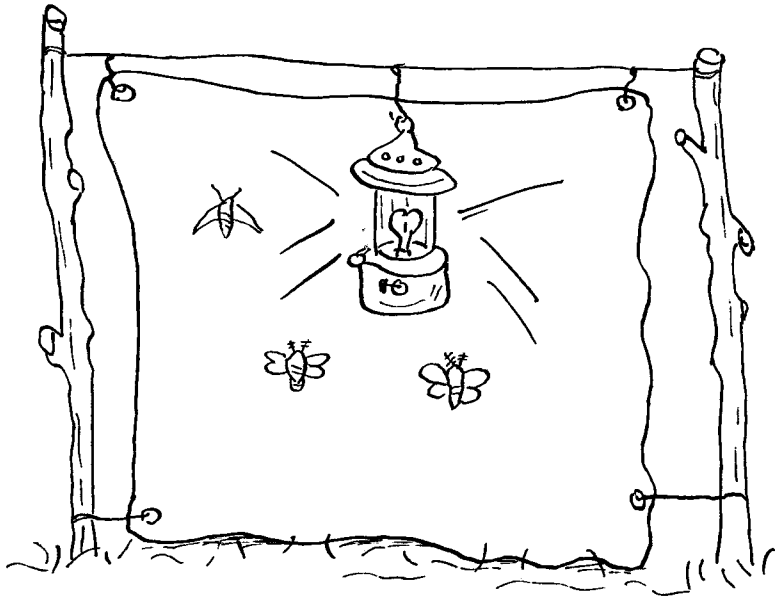
I am he that walks with the tender growing night,
I call to the earth and sea half-held by the night.
Press close bare-bosomed night-press close majestic nourishing night!
Night of south winds—night of the large few stars!
Still nodding night—mad naked summer night.
Walt Whitman—*Song of Myself*

The Entomologist was glad that he had brought a generator and blacklight ultraviolet trap with him to the high hills around San Luis Potosí in Mexico. He had a Coleman type camping lantern that he used in his tent, but it had been useless for trapping night-flying moths even on the high flat desert plateau that stretched to the east of the hills of San Luis Potosí.

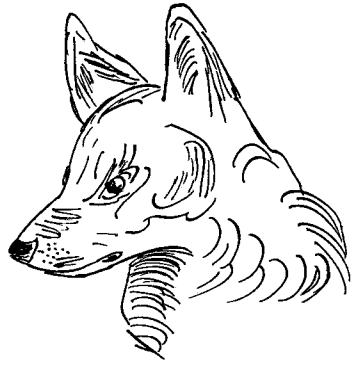
When the rough-looking Mexicans surrounded him at the trap he realized they meant him no harm but were merely curious about the strange light. They were, in their own primitive way, peasant scientists and those foolish moths

intrigued them no less than the Entomologist. They laughed at the light so the Entomologist shared his coffee with them.

Whenever the Entomologist ran out of gas for the generator he would use the highly inefficient Coleman lantern for a trap. The only way he could make it work, however, was to hang a white sheet behind it so that the bright light from the Coleman lantern reflected from the surface of the sheet. The best way to catch the moths was to pick them by hand because they went to the sheet and not to the bright Coleman burner. The Entomologist thought this strange because other entomologists were forever saying that moths went to the light.



They also said that the blacklight put out more ultraviolet (UV) light than the Coleman lantern, which was also strange for whenever he asked if they had measured the Coleman lantern they said no!



Now in the deserts and cool high mountains of central Mexico a very peculiar thing happened. Whenever the "hour of the wolf" came between three and four o'clock in the morning, the moths quit coming to the blacklight trap! "The hour of the wolf" is the name given to that period of nighttime in about every land by the peasants.

It is called "the hour of the wolf" because, for those who love the darkness—like werewolves and the Entomologist —it is the time when the sky is the blackest. The astronomers say that at that time the night sky is lit up by invisible ultraviolet blacklight from horizon to horizon. The human eye cannot see the UV blacklight the way an insect eye does, but blacklight does cause peculiar black flashes (hence the name) in the eye of the human. That is why blacklight bulbs are used in Eastern drug dens and Western discotheques where silly people go, like moths are believed to go to a light, to destroy their brains with drugs.

When the Entomologist returned to the lab he measured the visible and blacklight emitted by his AC bulb and his Coleman lantern. He was not surprised to see that the Coleman lantern put out 1,000 times more visible light than the blacklight bulb. He was surprised to find out, however, that although his AC bulb put out 900 microwatts of blacklight UV, his Coleman lantern put out over 600

microwatts even with the glass mantle around it and over 1,100 microwatts without the glass mantle! *The only difference he could see between the blacklight and the Coleman lantern was that the AC light flickered at 100 and 120 cycles per second,* depending on whether the power frequency was 50 or 60 cycles per second.

He slowly began to realize that so also did the street light at his house in Menands and the light over the door on the *Maria C* and the huge flame of light from Basra Petroleum Field No. 1. He also noted that the gentle south winds rippled the sheet behind the Coleman lantern so that the light on the surface flickered!

It was strange that large saturnid moths, that vibrated their antennas from 5 to 15 or 20 cycles per second, went to the white sheet behind the Coleman lantern, but that it did not do a very good job of attracting small- and middle-sized moths like his nocturnal owlet moths. He noticed that small moths vibrated their antennas at 50 to 90 cycles per second, much faster than the sheet rippled in the wind. The sheet ripple matched the large moth antenna vibrations!

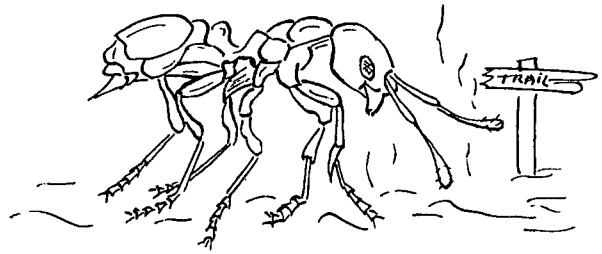
He asked some physiologists why moths vibrated their antenna. They did not know; furthermore, they did not seem to care for they had rather nail their antenna to a block of clay and study nerve impulses. Neither the shape nor the vibrations of those antennas concerned them the least bit.

Vibrations concerned the Entomologist, however, because he decided that maybe God knew what he was doing when he made insects with different size and shape antennas and different vibration frequencies. So he spent many more years studying the shape and the vibrations of all kinds of insects including the fire ant which followed an invisible trail and vibrated its antenna at 10 to 20 cycles per second just above the chemical trail. When the Entomologist remembered back to his boyhood he believed perhaps that might be the reason that the ants in the vacant lot next door to his

home in Denver so intrigued him. He did not, of course, understand at that time what those creatures were doing. Despite his youth, he did understand, however, from listening to bees hum and even the mosquitoes in his tent, that all insects were vibrating creatures.

In Mexico he decided that both the ultraviolet light and the vibrations must have something to do with the reason that moths and other insects were attracted to the air space around lights and flames and, yes, many years later to the air above *a glass of Guinness in a Westport pub.*

He decided to study the air around the bulbs and so he moved to Georgia and then to Florida where there were lots of night-flying insects and good administrators—the type that left him alone to explore vibrations and also to study the "hour of the wolf." They did not believe the Entomologist to be a werewolf—nor insist that he study moths from 8 to 5 o'clock.



Part V The Philosopher

Chapter 10

Tap Dancing on Molecules

We have varnished a metal by a gas, but a more interesting and suitable effect is by varnishing of one gaseous body by another.
John Tyndall—*Heat Considered as a Mode of Motion*

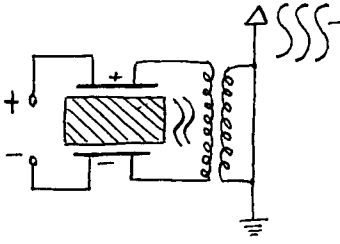
The Entomologist was really no longer an entomologist —he had been working in so many fields that it is perhaps more appropriate in our story to refer to him as the Philosopher.

He had, over a period of years, returned to Ireland several times because he considered it a beautiful land and was fond of its people, North and South, Protestant and Catholic alike. When he returned to the valley of the River Erne where first he thought deeply of life, there was naught left of the Belleek Range Station except the old brick transmitter hut. It had become a cattle shed and the great black 446 Radio Range and Z marker transmitters had long since been consigned to the scrap heap. Even the beautiful old castle nearby had been torn down for the aging timbers in its Tudor

insides. Only gray stones, creeping green vines and the raucous cry of jackdaws from the shattered walls remained as ghosts of the past.

The Belleek transmitter system had been based on the emission of radio waves from a quartz crystal. The crystal, when stimulated by an electrical voltage, vibrated and sent its radio wavelengths from the surface of the wire antennas and thence to the air space over the Atlantic Ocean.

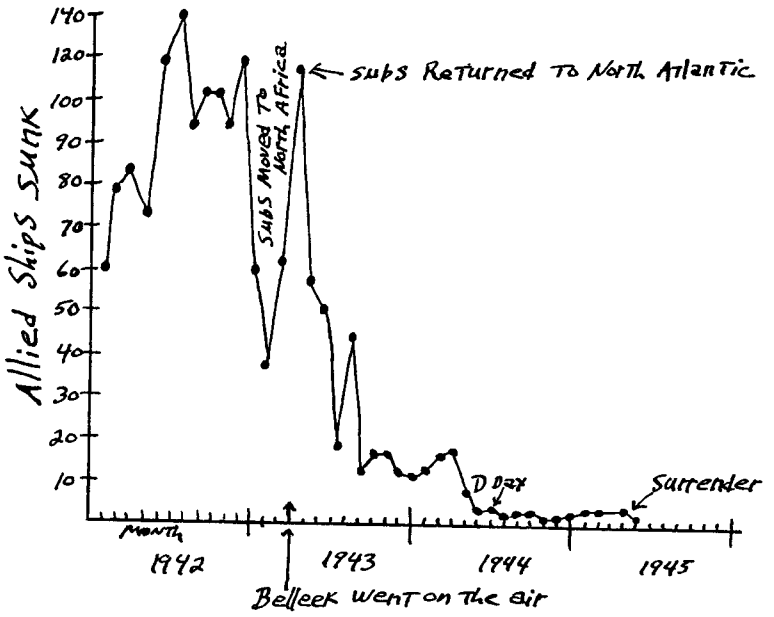
The Philosopher understood that, although the system was primitive by modern standards and used vacuum tubes invented by Lee De Forest and also resonant circuits invented by Nikola Tesla in the 1890's, it had nevertheless done its job of getting the sub sinkers to sea and back very well indeed.



When the Philosopher put together the figures on Allied ships lost to German U-boats it was evident that the end of the German submarine fleet and the "Battle of the North Atlantic" began with the installation of the Belleek Radio Range and the flights of sub sinkers. It was pleasant to remember that in those days the Americans, Irish and RAF worked very well together and that the Irish Free State always helped the Americans when things went wrong such as when they needed a doctor from the south or had to bring crashed fliers back across the border. On paper the Irish Free State was neutral, but in their hearts they did everything they could to help the Americans and their RAF allies of the Coastal Command.

The RAF Coastal Command utilized the radio signals in the air space over the stormy North Atlantic. When the planes were far out to sea, 500 miles or more, they used the radio compass to home in on the RAF signal from a station at Farrancassidy Cross between Belleek and Garrison.

When they got close to the coast, 100 miles or so out, they switched to the Belleek beam so they could ride it through storm and fog to a pin-point landing on the lough. There was



a long-distance method and a short-distance method that the airmen utilized to get home. Finally there was a Z marker that told them when they were in the air space above the Belleek station.

Now it seemed to the Philosopher that if that was such a good system for the brave British sub sinkers, then maybe it was a good system for corn earworm moths, cabbage looper moths and even the ghost moth of the Pullan Brae. Since the Philosopher was engaged in a war against insects that destroy crops, he did not wish to harm the neutral and beneficial insects. He did not like insecticides at all for they are too much like an atom bomb that destroys everything in

sight, when all you want to eliminate is your enemy.

Even as far back as the nineteenth century, entomologists such as the Frenchman Fabre knew that insects were attracted to scents, and the great Irish physicist-biologist John Tyndall showed that scents were actually vibrating molecules that emit infrared radiation. In 1863 that genius from Leighlinbridge in County Carlow, Ireland, wrote a book called *Heat Considered as a Mode of Motion.* In it he described how molecules of perfume scent such as pachouli, sandalwood, oil of cloves, lavender, attar of roses, lemon, thyme, rosemary, oil of laurel, spikenard and aniseed, absorb radiations. John Tyndall, the genius from County Carlow, wrote in beautiful Victorian language about the "action of scents on radiant heat." This was all very interesting because the Entomologist-Philosopher had been writing (only from the opposite viewpoint) for twenty-five years about the "action of radiant heat on scents" and had never heard of John Tyndall for the simple reason that Tyndall's elegant work was ignored by the modern chemists and olifaction physiologists.

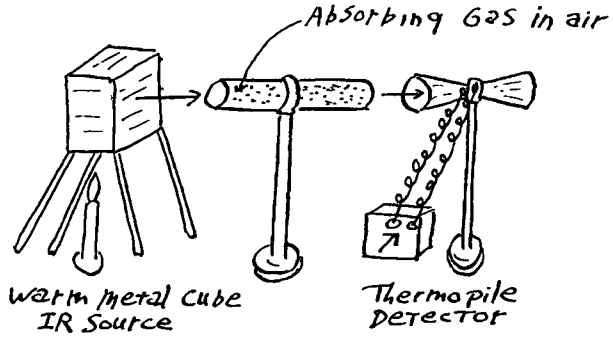
In 1866 Tyndall wrote:

The number of atoms of air here in the tube must be regarded as almost infinite in comparison with those of the odours; still the latter, thinly scattered as they are, do, in the case of pachouli, 30 times the execution of the air; attar of roses does upwards of 36 times the execution of the air; thyme, 74 times, spikenard, 355 times and aniseed 372 times the execution of the air. It would be idle to speculate on the quantities of matter implicated in these results. Probably they would have to be multiplied by millions to bring them up to the tension of ordinary air.
Thus:

The sweet south
That breaths upon a bank of violets
Stealing and giving odour,

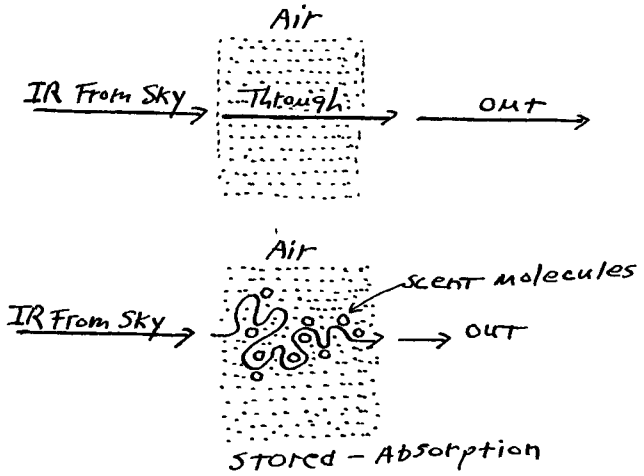
owes its sweetness to an agent, which, though almost infinitely attenuated, may be more potent, as an intercepter of terrestrial radiation, than the entire atmosphere from "bank" to sky.

This simply states that air space is made up of many many specific molecules of oxygen, nitrogen, argon and ammonia, etc., etc., but that scattered thinly among those billions upon billions of air molecules are spread very few molecules of scent substances, which block infrared light better than air alone. The Philosopher discovered that John Tyndall invented the instrument called the absorption spectrophotometer.



He used his absorption spectrophotometer to demonstrate that when a very few molecules of a scent are released into air space the scent causes the character of the air to change so that it absorbs (takes in) far more infrared radiation from the sun, night sky, or stars than it would if the scent were not scattered thinly in the air. The combination of thinly-spread scent molecules, plus the gases that compose the air, act together, so to speak, to trap the radiation within itself.

Now the Philosopher knew from the work of laser physicists and physical-chemists that any organic molecules that can absorb (take in and store) radiation efficiently can



also be stimulated, by heat or other mechanisms, to emit efficiently. The work of Tyndall and modern physicists told him that very few scent molecules spread thinly in the air are capable of emitting infrared radiation for the simple reason that they are efficient at absorbing radiation from the environment. In other words, *a little means a lot!*

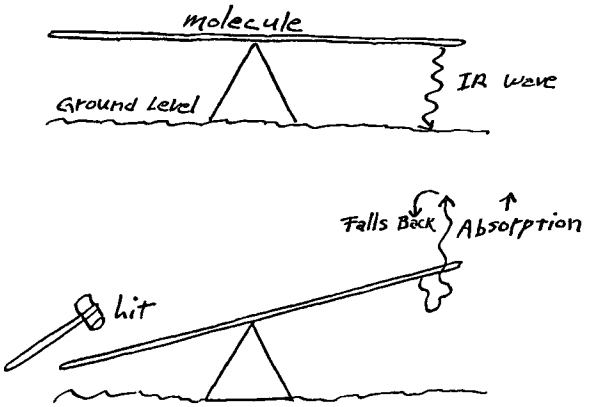
Spread thinly in the atmosphere are millions upon millions of potential little infrared emitting transmitters which, if manipulated in the proper manner, can be made to emit infrared wavelengths the way a quartz crystal oscillator emits radio waves. The Philosopher knew that the question to ask was "*how does one manipulate the scent molecule to cause emission?*"

The Philosopher, who really did not enjoy long mathematical computations, decided that the simplest way to answer the question was to look at the air space above a glass of Guinness, around a flame, or around a light bulb, with an instrument, like Tyndall's, that could "see" the radiation if he treated the scent exactly the same way the insect did—in other words, if he mechanically *vibrated* the

scent molecule. Electrical engineers call this *modulating* the wavelength.

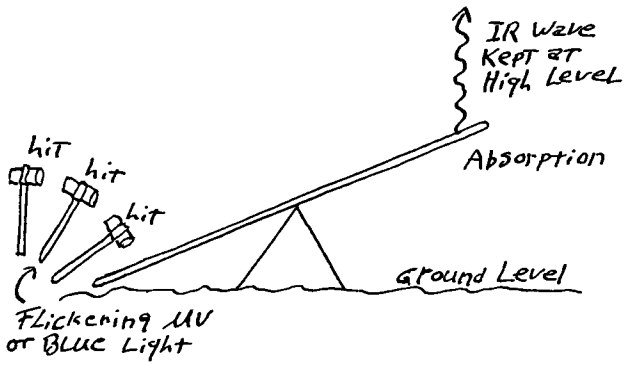
Modulation is not a hard concept to understand. The Philosopher knew that all molecules that emit photon light energy are similar to bouncing rubber balls or vibrating rubber bands. If the scent molecules were hit with flickering UV or blue light at the visible end of the spectrum then perhaps, the Philosopher believed, it would cause the infrared photons to bounce out of the other end, the long-wave end of the spectrum, as coherent infrared radiation.

A photon, of course, is a small bundle of light or infrared energy. It works like this:

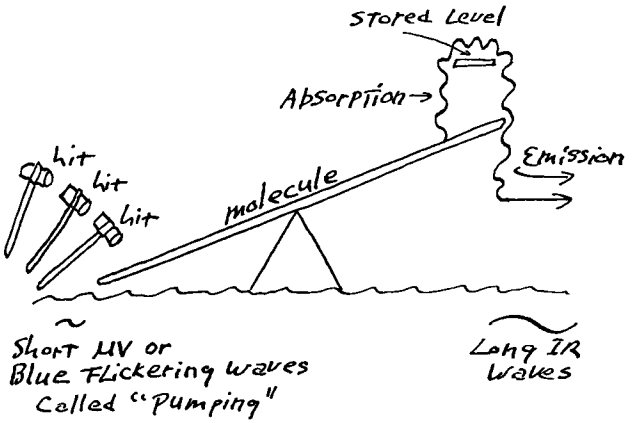


The Philosopher could see that if molecules were really like vibrating rubber bands as the physicists and physical-chemists said, and could be made to vibrate by shining light on them, then just hitting the scent molecule once (as with a DC flashlight or one-time vibration hammer blow) would knock it up to a high level of energy, but the energy would just fall back to ground level and emit nothing. If, on the other hand, he *flickered* the light so that it hit the molecule

again and again, the energy would be kept bounced up to a high level and remain as if it were stored on the top floor of a building like this:



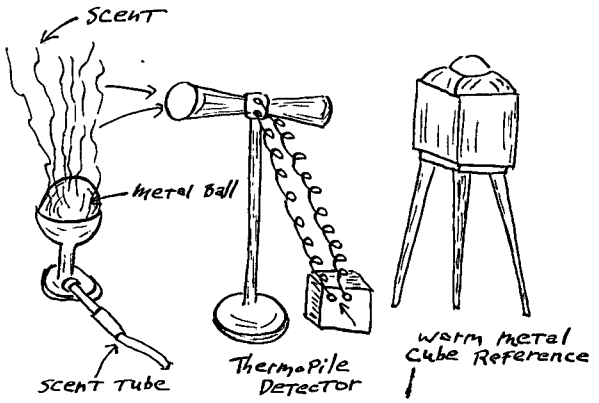
The problem for the Philosopher was, of course, to find the correct modulation frequency (hammering or tapping frequency) that would cause the photon energy to stay on the second floor long enough to be stored before falling back to ground level. It might then gain enough energy to emit infrared wavelengths in this manner:



Physical-chemists call this particular type of system where high energy visible, or UV light, goes in at the short wavelength end (~) of the spectrum, and the absorbed (stored) longer wave visible, or infrared waves (~~~), are bounced out at the opposite end of the spectrum: *fluorescence.* Nikola Tesla used this principle to invent the first visible fluorescent tube in the 1890's. He shined UV light on a white powder called a phosphor and caused the powder to glow and emit the longer visible rays that the human eye can see. It is the glowing white phosphor coating on the inside of the bulb that we see.

Of course the Philosopher was not looking for visible rays but much longer infrared rays that were of the same wavelength as the length of the spines on the insect antenna he had measured with the light microscope. He was looking for infrared wavelengths 10 to 30 microns (millionths of a meter) long ($^{10}/_{1000}$ to $^{30}/_{1000}$ of a millimeter long). These are very tiny waves, but are nevertheless much longer than visible waves that are $^{0.4}/_{1000}$ to $^{0.7}/_{1000}$ of a millimeter long.

John Tyndall, besides inventing the absorption spectophotometer that "sees" the absorbed (stored) wavelengths, also invented the emission spectrophotometer that "sees" emitted infrared radiation.

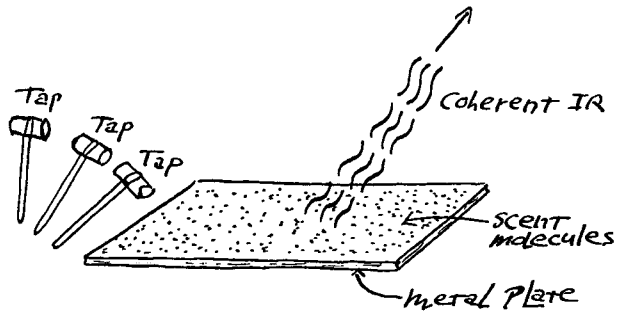


The Philosopher read in the book *Heat Considered as a Mode of Motion* that the great Irish scientist found out that if he blew the scent molecule across a slightly warmed metal surface, or bounced one scent gas against another gas, that the molecules would collide with the surface or the other gas and would emit its stored (absorbed) infrared radiation.

Tyndall looked at the radiation from many, many odors with his emission spectrophotometer. He called his elegant experiments "varnishing" a metal with a gas, or "varnishing" one gas with another gas.

The Philosopher had never heard of John Tyndall, for that genius was fairly well ignored by scientists, who nevertheless used his ideas and inventions in their own work. The Irish genius is insulted in the *Encyclopaedia Britannica* (1953) which states: "Tyndall's contributions to science are due more to his personality and his gift for making difficult things clear rather than to his original researches." This, despite the fact that Tyndall is the father of the entire science of infrared spectrophotometery, which is the basis of all analytical chemistry. He also discovered the effect of penicillin eighty years before Sir Alexander Fleming! As in the case of Nikola Tesla, the work of Tyndall was utilized by others without giving him the credit that he deserved. John Tyndall was also one of the world's great mountaineers and has numerous geological formations and mountains named after him all over the world.

Long before the Philosopher had read about Tyndall's early work he had started investigating insect sex scents (pheromones as they are called) and plant odors with a new type of spectrophotometer that uses moving mirrors as antennas to collect and resonate to narrow-band infrared radiation. He discovered that he could not only see the stored (absorbed) infrared wavelengths, which were very broad band, arising from scent molecules, but he could also cause the molecules to emit coherent infrared wavelengths



by mechanically tapping or vibrating a thin layer of the scent which had been coated on a metal plate. In other words, he was doing to the odor molecule exactly what the insect does to an odor when it is searching the atmosphere with its oscillating or vibrating antenna or when it is repeatedly tapping surfaces to look for spilled food, as fruit flies and house flies do. He was *vibrating* a thin layer of scent molecules. We might call this phenomenon "mechanical fluorescence."*

John Tyndall called his experiments "varnishing a metal with a gas." The Philosopher called his vibration experiments *tap dancing on molecules!*

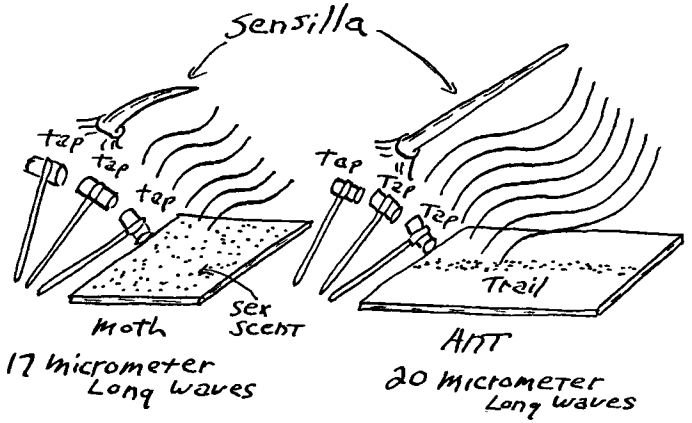
*As I was proofreading this book, the latest copy of *Optical Letters* (September, 1980) came across my desk. In it, R. W. Falcone and G. A. Zdasiuk of Stanford University observed what they call "radiative collisional fluorescence" from thermally excited atoms. The emissions are in the UV–violet region. This phenomenon (collisional) is essentially the same as my mechanical fluorescence in the IR region from organic molecules.

Chapter 11

Living Lasers

Gasdynamic lasers are truly interdisciplinary devices. The concepts and design of gasdynamic lasers cut across such disciplines as quantum mechanics, statistical thermodynamics, physical chemistry, nonequilibrium gasdynamics, physical optics, and the aerodynamics of internal flows. It is unrealistic to assume that any single person is a master of all these fields.
John D. Anderson, Jr.—*Gasdynamic Lasers*

Now my reader may well ask how the Philosopher found the right mechanical vibration or tapping frequency for each insect he studied. Since the Philosopher did not like to manipulate long complex formulas, he used a very simple method. Whenever a chemical that attracted some species of insect was discovered, such as the sex scent (pheromone) of the cabbage looper, or the trail scent of an ant, he coated the molecules of the chemical as a thin layer on a metal mirror and then tapped or vibrated the mirror at the same frequency (cycles per second) at which the insect vibrated its antenna when responding to the scent chemical.



For each scent he always picked up the *infrared* wavelength that he predicted and each time it was the proper length to match the spines on the moth antenna!

Now science is a very peculiar profession and the Philosopher believed that perhaps God had a lot to do with great discoveries by mankind. The reason he thought this is because of a peculiar phenomenon of science called *insight* that no human can explain. All great scientific discoveries are preceded by insight somewhere along the long road of experimentation.

Nikola Tesla, besides inventing radio and the fluorescent tube, and the first remote control system and much more, also invented the AC motor. Whenever anyone asked him where he got the idea, he said that he was in a public park in Prague thinking about magnetic fields when he gazed up at the sun and had a sudden vision. He stooped over and began drawing the design for the AC motor in the dirt walkway.

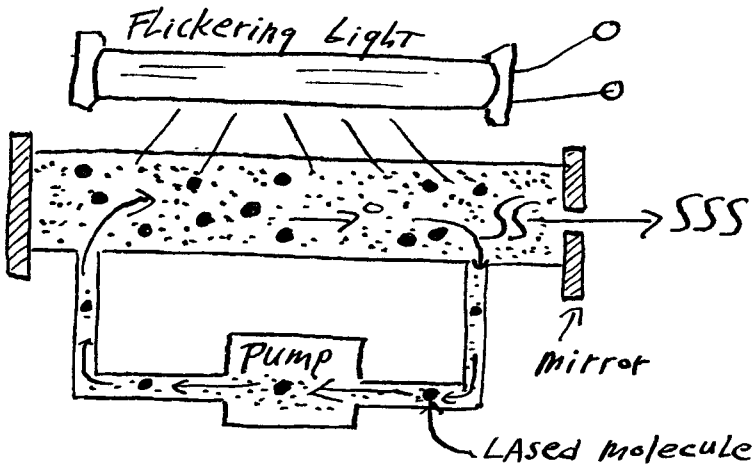
Most scientists would probably prefer the word insight for Tesla's flash of understanding rather than the word *vision.* Few would deny that the phenomenon occurs, but the word vision has mystic and religious connotations. It is indeed strange that so many scientists, who may go to church on Sunday, leave their beliefs behind when they reach the lab on Monday. They would probably be surprised to learn that in the Greek language, a *theorem* is the object of a vision.

Be that as it may, the Philosopher had thought for so long a time about resonance and molecules, lasers and radio, ants and moths, antennas and mirrors, that one day he asked himself why most of the night-flying moths have *long log-periodic* antenna arrays like this: ◦⋕⋕⋕ but that the ghost moth had *short* stubby antenna arrays like this: ◦⋕

Now what had led up to that question was the Philosopher's love of reading technical papers on lasers. Most lasers operate like fluorescent tubes, but they put out coherent light like radio transmitters. That is why in the light region of the spectrum scientists use mirrors for antenna. Lasers work by tapping the fluorescent emission between two mirrors at a rate that corresponds to the wavelengths emitted by the fluorescent gas. A flickering strobe light of UV or blue visible light is focused from a bulb onto a tube with a carrier gas like nitrogen flowing through the tube pushed by a pump. The chemical to be lased is mixed with the flowing carrier gas and the two mirrors, one at either end, are adjusted to form a resonant space between them. The principle is the same as that of a radio antenna in that the radio antenna is cut and the laser mirrors spaced to match a special wavelength. Spaced mirrors are antennas. They are called open resonators, because they are not entirely enclosed by walls like a resonant cavity.

One may think of mirrors as a bit like the sound box of a violin which is shaped to collect the sound waves that bounce back and forth until they all come out amplified and in tune, though the violin accommodates many frequencies and with less amplification. The stimulated infrared energy bounces between the mirrors and all comes out *coherent*—in step like marching soldiers. In the case of the insect, the resonant system is not a cavity but the correct length of surface of a spine. Thus, insect spines are closer in principle to antennas

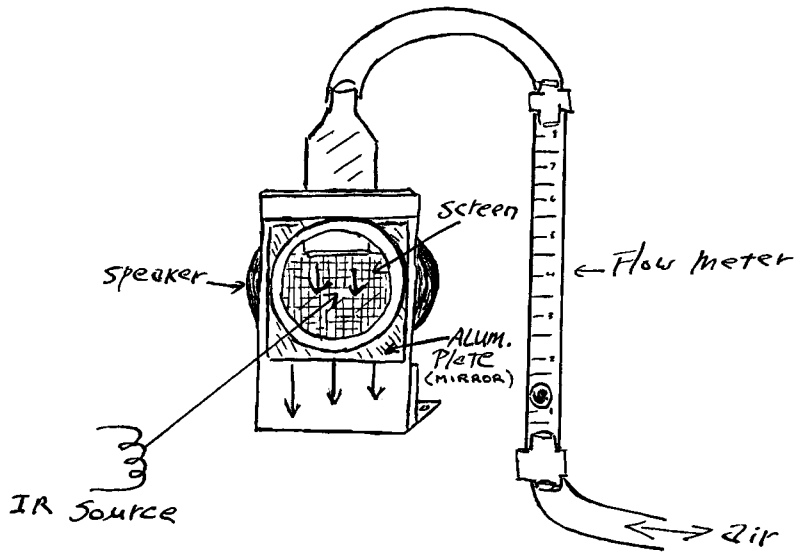
than to mirrors. They were called *dielectric antennas* by the Philosopher because they are made out of a *dielectric* substance (wax) which is closer to an insulator substance than to metal.



Now it is evident as mentioned before that *a little means a lot*—the little, of course, being the scent molecules that "dope" (as physicists say) the billions upon billions of carrier gas molecules. It is also evident that, as the molecules move or flow through the tube, even more energy is obtained because the lasing molecules knock against the carrier molecules and bounce around far more than they would if they were not flowing. *In other words, not only does systematic vibration modulate, but so also does the randomness of flowing!* That is why Tyndall, when he blew his odors across a warm metal ball, obtained emission from the absorbed (stored) energy in his scent molecules. If he had enclosed his flowing molecules in a tube between correctly spaced mirrors he would have invented the laser in 1863!

Of course it took but a few simple deductions, based on such laser work, for the Philosopher to find coherent infrared radiation from the insect odors he studied. He merely blew them across a metal plate at a known wind speed and vibrated the plate at the same frequency the insect vibrated its antenna. The simple system that he finally utilized to study insect odor infrared emissions he called a "gasdynamic organic laser" or "maser" and it looked like this:

In this system the Philosopher used a hot filament, which takes the place of the radiation from the sun or night sky, and gives off the infrared radiation that the molecule must absorb (store up) before it can be modulated (vibrated) and caused to emit the narrow-band coherent radiation. There was also plenty of blue and UV light on the mirror coming through the lab windows onto the mirror. Behind the metal mirror, which was nothing more than a square of aluminum foil on a metal plate, was a sound speaker that could be made to vibrate anywhere from 5 to 500 cycles per second. *The mechanically vibrating mirror shakes the reflected blue and UV light so that it modulates the thin layer of scent molecules on the mirror and causes them to emit their stored infrared wavelengths.* The scent was blown through an air flow meter (which reads wind speed) across the vibrating plate. The infrared coherent wavelengths were emitted straight out the front and were recorded by the Philosopher's spectrophotometer which is a very special type called a high resolution Fourier Transform Spectrometer. High resolution means it can see very narrow wavelengths just like a high resolution telescope can see small distant planets, whereas cheap field glasses cannot see such fine detail.



Organic Laser

When the Philosopher studied the cabbage looper sex scent, or pheromone, he set the speaker at 55 cycles per second because that is the frequency at which the moth vibrates its antenna. He also set the wind speed flow at one to two miles per hour because that is the optimum night breeze for most night-flying moths. Moths do not fly as much on still nights and not at all during hurricanes.

Air Force laser researchers had discovered that if they heat the laser gas up to a million degrees and blow it out a specially designed aperture, so that it heats and cools very fast, they can produce laser beams that will melt metal. Presumably they prefer such high power infrared beams because they make nice zap-beams for shooting down rockets and missiles. They call them gasdynamic lasers.

Unfortunately, the Philosopher found that most biologists think in terms of only high power zap-zap lasers and did not understand his weak little organic scent lasers at all. One might say that most researchers think in terms of a 50,000 watt aircraft searchlight laser whereas the Philosopher had discovered a 1/1,000,000 watt natural flashlight laser. However, the gasdynamic principles are the same!

Instead of heating the scent up to plus or minus millions of degrees, which would destroy organic molecules, the Philosopher was stimulating laser emissions at room temperature —the temperature of nature! He called his emission *maserlike* for Molecular Amplification of Stimulated Emission of Radiation, instead of *L*aser for Light.

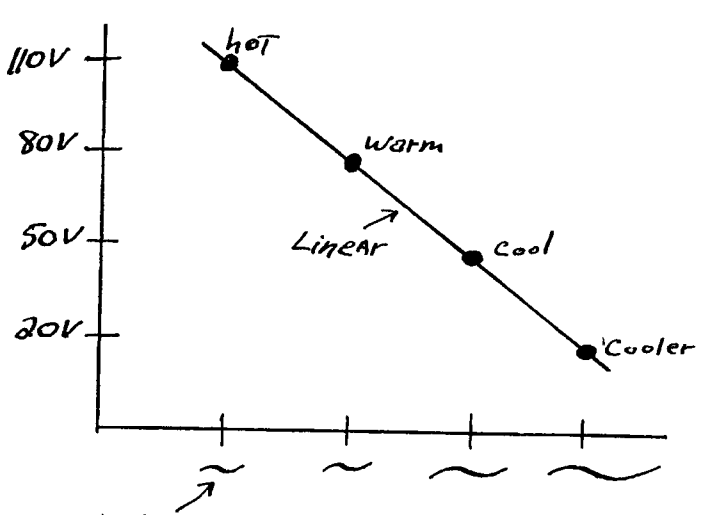
The question of the long log-periodic antenna and the short ghost moth antenna still bothered the Philosopher until one night God privileged him with sudden insight, or vision, or whatever the reader of this tale wishes to label it.

It happened when the Philosopher was lying in bed. Clear insights often come to him after a day of hard thought and just before dozing off to sleep. For some reason he recalled the problems he had in Belleek with the quartz crystal that vibrated and sent out the radio range signal. In a flash it came to him that all such systems, lasers included, are *nonlinear* and that their wavelength depends on temperature!

Simply put, *linear* radiation is the type that comes from a hot stove, or light bulb filament. The more the voltage is applied, the hotter it gets and the shorter the wavelength it emits. That is why an electric stove or furnace can be warm but does not give visible light until you turn the voltage up very high. First it turns red, then orange, then white hot (bluish). The red colors are of longer wavelengths (0.7 micrometers long). Such radiation is called blackbody (heat) radiation and is given off by all bodies above absolute 0 (minus 273° Celsius or Centigrade absolute temperature).

The cooler the body, the longer the wavelengths; the hotter the body, the shorter the wavelengths.

A temperature is finally reached where visible radiation is given off. It can be diagrammed like this:



Such radiation is very broad band and incoherent, so it contains many, many wavelengths emitted in all directions.

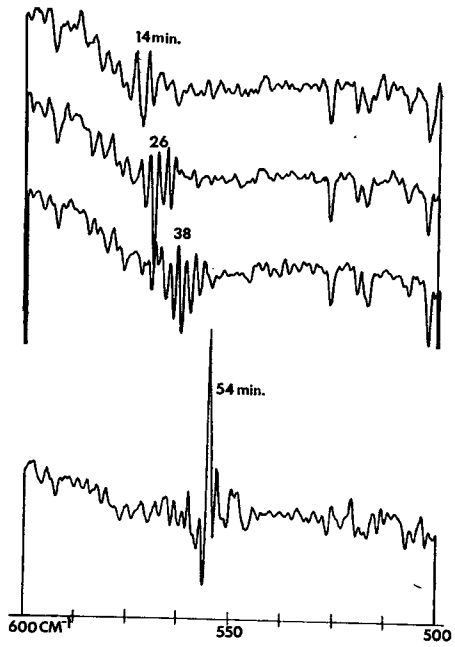
The Philosopher could not get visible light from an organic molecule by heating it to high temperature because that would destroy the molecule. However, since molecules are like vibrating rubber bands or bouncing balls, they can be made to vibrate faster and faster, and higher and higher in amplitude by very slightly warming them at room temperature, or by allowing them to flow gently through the atmosphere at room temperature. It is almost impossible, except by knowing the shape of the molecule, to predict where the radiation will shoot out or how strong it will be. This phenomenon is the opposite of blackbody (heat) radiation, however, in that the more one warms the

molecule the longer the wavelengths, instead of the shorter. Since it is apt to emit anywhere, depending on molecular shape and the angles its vibrations make, it is called *nonlinear radiation.* Emission depends not only on shape, but also on absorption characteristics, and on the optimum flowing speed of the molecules and the concentration in the system.

What the Philosopher realized in a flash was that the soldiers at the Belleek Radio Range had to constantly check the temperature of the vibrating crystal because if it changed even one degree the wavelength of the radio emission would shift and *detune the entire system.* This could be disastrous for the RAF flier who was depending on it over the Atlantic Ocean. If the crystal was too warm it would expand and the wavelength would shift upward and the frequency downward. The engineers that designed the system placed the crystal in a controlled temperature chamber. Every hour on the hour, night and day for three long years, whoever was on watch read the meter to make sure the temperature of the quartz crystal was within tolerance. The Philosopher realized that if the quartz crystal vibrating oscillator could shift wavelength from such a slight temperature change, then an organic molecular oscillator would be even more susceptible to minute temperature change.

At this point the Philosopher jumped out of bed and wrote in his notebook: "All life is nonlinear!" The next morning he was very excited as he put some cabbage looper sex scent in an enclosed glass tube, the scent being the molecule to be lased, and the ordinary room air, with all its molecules and water vapor (60 percent humidity), being the carrier gas. When the philosopher looked at the mixture in the tube at 10 minutes, 15 minutes and 20 minutes, with his spectrophotometer the expected happened!

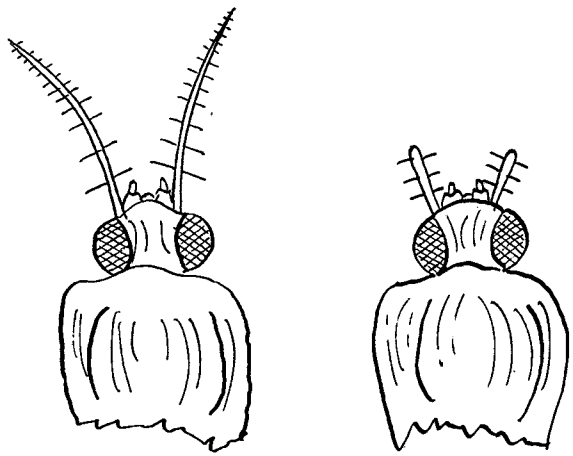
As the concentration of the sex pheromone increased by evaporation from the inner surface of the tube and as the



filament slowly raised the temperature of the gas, the infrared emission slowly shifted to longer and longer wavelengths. The change in temperature was less than 2 degrees Fahrenheit!

The Philosopher had wiped a considerable amount of pheromone onto the inside of the tube, so the emission was quite broad. It is a fact of physical chemistry that the more gas there is in such a system, the broader the wavelength of emission, and the less gas, the narrower and more coherent the wavelength of emission.

When the Philosopher applied just a few pheromone molecules to his vibrating mirror (55 cycles per second) it emitted very narrow laser lines which also had side band waves on either side of the high amplitude main emission lines, just like a radio station. Side bands are wavelengths



spaced equally on each side of the main wavelength and are characteristic of modulated coherent emitters. The narrow-band pheromone emission from the thin layer also shifted to longer wavelengths as it was slowly warmed.

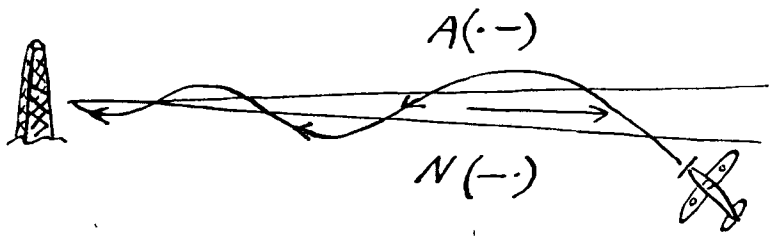
From this significant experiment the Philosopher knew immediately why the corn earworm moth and cabbage looper moth have long log-periodic antenna and the ghost moth short stubby antenna with spines of uniform length. He had discovered the secret of the Ghost Moth, but even more important, he had discovered the first living laser!

Chapter 12

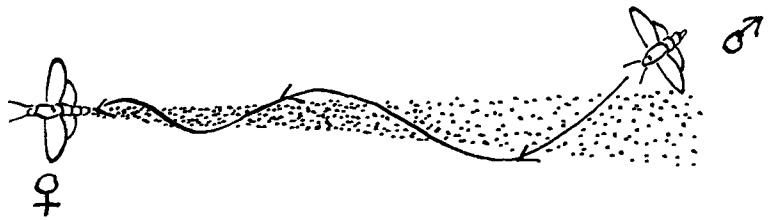
The Candle and the Moth

Thus hath the candle singed the moth.
O, these deliberate fools!
Shakespeare—*The Merchant of Venice*

Now all World War II pilots know that fliers in the old days followed a radio range signal like this:



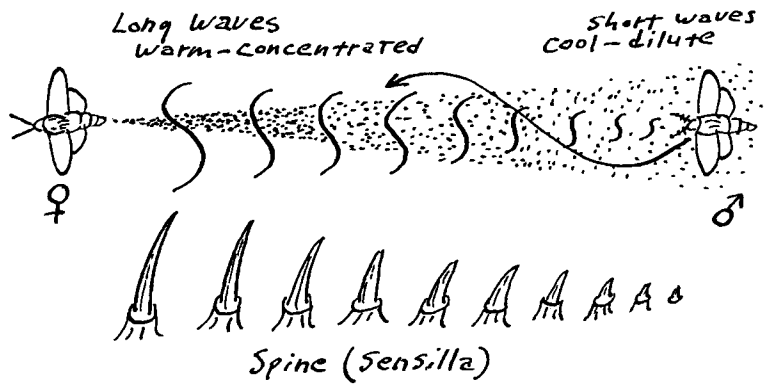
and every competent entomologist knows that all night-flying moths follow a pheromone (sex scent) trail like this:



Every entomologist also knows that the sex odor of the female emits from the scent gland at the top of her abdomen as she vibrates her wings. During emission her temperature increases 6° to 18° F above that of the air space. This means, of course, that as the scent drifts through the air pushed by the gentle breeze, it cools and decreases in concentration. The scent flows along in the water vapor of the gaseous atmosphere which is the carrier gas.

It is warm and concentrated close to the female's body but dilute and cool hundreds of feet away. In other words, the infrared nonlinear laser frequencies are shifting to shorter and shorter wavelengths the further it drifts. It is a natural drifting radio range station, but it is different in that in each area of concentration along that pathway it is transmitting its own coherent infrared signal so that close to the female the wavelengths are longer and hundreds of feet away they are shorter. Laser physicists call this "concentration tuning."

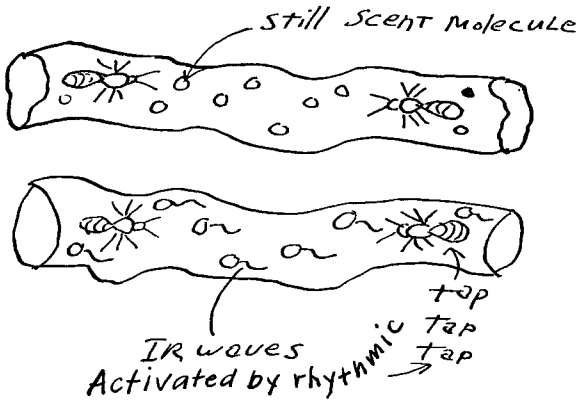
Since the female emits the sex pheromone at a constant rate for one half to one hour, the beam remains in place as long as it is not dispersed by high winds. The male utilizes short spines, which resonate to the short wavelengths far away, and the longer and longer spines as he closes on his future mate like this:



The system tells the male exactly how far he is from the female, so it is actually superior to the radio range system.

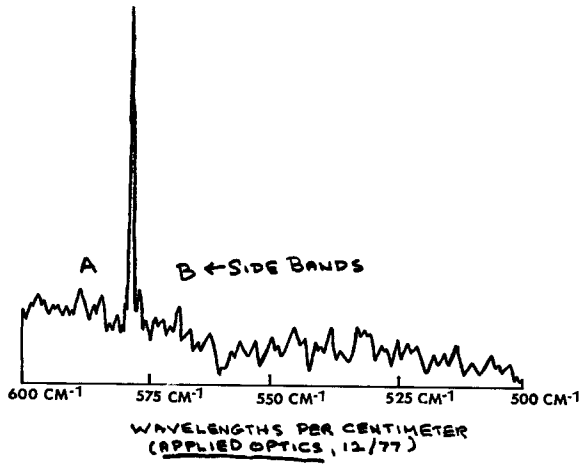
Decoding this elegant infrared transmission system told the Philosopher immediately why the cabbage looper and the corn earworm moths have long antennas—the reason being, of course, to support the long series of antenna spines that resonate to each shifting wavelength along the pathway. The Philosopher also realized that the same principle held for the fire ant, which follows a ground laid trail, and has long antennas with spines arranged short at the tip and long at the base.

The Philosopher also believed that ants and termites communicate in their dark tunnels, which are filled with organic gases, by the tap-tap-tapping and modulating of the gases, so that the molecules emit coherent infrared signals along the length of the tunnel like this:



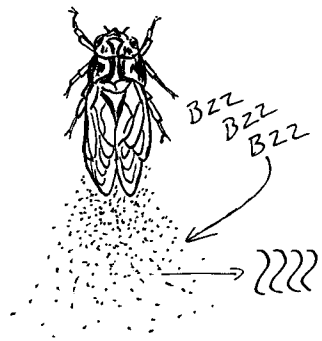
He also believed that all social insects, such as ants, wasps and bees, identify themselves to each other by tap-tap-tapping against one another's bodies, since they are coated with a colony identification pheromone. What a beautiful system, the Philosopher thought—that an insect could

tap-tap-tap another and cause the identification molecules coating their bodies to emit coherent infrared radiation like this:



Many insects produce sound by rubbing a file on their wings or legs against another rough spot on their bodies. Such sounds produced by crickets, cicadas, and many other insect species, vibrate at specific cycles per second. These waves, traveling through the air, modulate the chemical oscillators that are given off from insect glands, or evaporate from the surface of their bodies.

The Philosopher knew that entomologists could not decode any complex system utilized by insects for communications until they studied sound, tapping, stridulations and other pressure waves of the air spaces as integral parts of the insect scent detection system.



It is the complex hit-hit-hit pressure waves that knock the free-floating scent molecules into their nonlinear infrared emission phase. As long as sound is studied in one corner of the lab and scent in another, the mechanisms of these sound-modulated scent systems will not be understood in other species of insects.

Since the blue and UV light from the sky is flickered by the vibrations of the insect, it hit-hit-hits the scent molecules especially hard when the sky is flooded with such light during "the hour of the wolf."

The Philosopher realized that the blue or UV from a light bulb or blacklight is much stronger than that of the night sky, so that the moths and other insects are highly attracted to the space around the man-made emitters. The light stimulates the molecules in the air space to a high energy level. If there is a plant scent or pheromone floating in the air then the blue–UV radiation from the night sky cannot compete with the energy going into the molecules beneath the light bulb.

Physicists call the short-wave flickering energy that hits one end of the spectrum and which knocks the infrared fluorescent energy out of the other end the "pumping" energy because it pumps the photon energy up high so that it can store and emit as it falls back to ground level. The "hour of the wolf" and the beautiful sky are "natural pumping" sources. Of course, until Nikola Tesla invented the AC motor and fluorescent bulb the poor moth did not have such man-made disrupters of its sex life to deal with.

The Philosopher noticed that the male cabbage looper moth will fly to a candle and die in the hot flame. Now that seemed to the Philosopher a very silly thing to do, so he measured the far infrared emission of a candle with his high resolution Fourier transform system. He was not surprised to see that both the candle and a Bunsen burner emit narrow-band infrared emissions in the far infrared. The

bands from these flickering hydrocarbon burners exactly match the infrared nonlinear emissions from the cabbage looper sex scent. The candle, surprisingly enough, also puts out hundreds and hundreds of other narrow-band infrared wavelengths so that it is a shotgun emitter of wavelengths that mimic the scent wavelengths of many other insects. This accounts for so many insects being attracted to candles and gases from flickering petroleum burn-off pipes such as those at Basra Petroleum Field No. 1. As the hydrocarbons from the gas flames heat up, they flow into the air and cool. Not only is the flowing gasdynamic principle present but also, since the flame gives off UV and blue light and flickers, it self-modulates the cooling hydrocarbon molecules as they flow into the night air. The philosopher also looked at the Coleman lantern and found that it did not emit nonlinear, narrow-band infrared radiation because it does not flicker and modulate itself; so this lamp is not a good mimic of any insect attractant scent as are the Bunsen burner and wax candle. The poor moths think those latter flames to be beautiful maidens. The flames are the *femmes fatale* of the insect world.

The Philosopher was much older when he began to realize that the real beauty of nature was not in color, or form visible to his own eyes alone—although that was a part of it—but rather the vast interrelated forms of life itself, a life where form and wavelength are connected one to another like the boy to his hawk, the hoopoo to the moth at the painted door, and, yes, even man to woman.

The Denver library on Montview Boulevard did not have books on what life is really about, only books on what the human eye sees and therefore thinks it to be. Those books did not say a thing about the interrelations of form and wavelengths which go one with the other like ham and eggs; nor did they say that love might be a vibrating molecule.

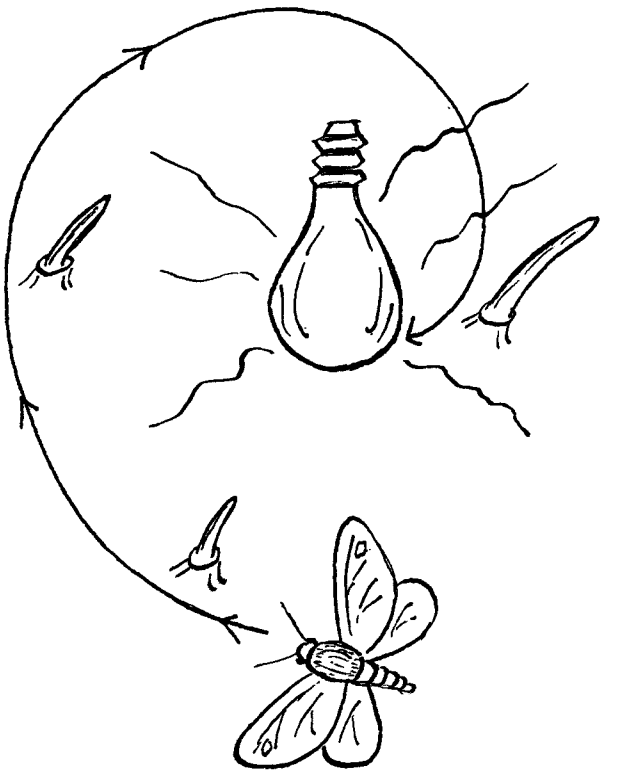
The Philosopher knew that he would probably never get a

great prize for his discovery, for great prizes are reserved for specialists who discover specialized things and not for philosophers who discover something new about life. That is the price he paid for being a philosopher and not an entomologist. He did not care, for the simple reason that he knew in his heart that he was the first human being to look at a moth above a glass of Guinness and know exactly why it was in the air above that glass of Guinness in a Westport pub, and why it flew in silly circles. The feeling must be similar to being the first to fly the Atlantic alone, or to stand on top of Mount Everest, or to float across the ocean in a balloon. The fact that one does it is reward aplenty!

You see, my dear reader, the reason that moths fly in silly circles around lights is simply because the infrared emissions from scent under the heat near the center of the bulb are stronger and longer wavelengths than those at the outer circumference. The scent pattern is circular and not beam-like as is the case of a radio range trail through the air. Therefore, on a still night the short spines work at the outer edge and the larger and longer spines pull the insect inwards towards the stronger and stronger and larger and longer wavelengths until the poor foolish moth is drawn right to the flickering light or gas flame. *It is the antenna that is responsible for the attractant force and not the eye at all!*

Of course, if the bulb has a glass mantle around it, like the porch light that the Philosopher's mother asked him to clean out, then the scents are blown out by the heat through the cracks and each crack becomes a mimic gasdynamic laser with the stimulated molecules flowing outwards and cooling in the night air. As more and more insects follow the thermal molecular trail into the globe, then more and more of the organic attractant scents fill the chamber from their little organic bodies—fuel for the scent gasdynamic laser. O wretched gasdynamic porch light laser, thy name is subterfuge.

The Philosopher felt sorry for all those little beetles and moths that Nikola Tesla had tricked with his AC motors and light systems, and Nikola Tesla would have also felt sorry had he known, for he was that sort of human being.



Epilogue—Ghost Moth Again

Give me to recognize in other men, Lord God, the radiance of your face. The irresistible light of your eyes, shining in the depth of things, has already driven me into undertaking the works I had to do and facing the difficulties I had to overcome.
Pierre Teilhard de Chardin—*Hymn of the Universe*

For the Philosopher the beauty of science lies in the hearts of all those who practice the art—some perhaps sloppily but most with the elegance of souls filled with awe for God's subtle biological and physical systems. The chemist with his love of molecules, the ornithologist of birds, the physicist of electrons, the entomologist of insects that follow trails, and so on. All contribute to the soup of life that the philosopher needed to partake of, in order to discover the soul of the ghost moth. Without the work of such men and women, the Boy would never have grown into a Philosopher.

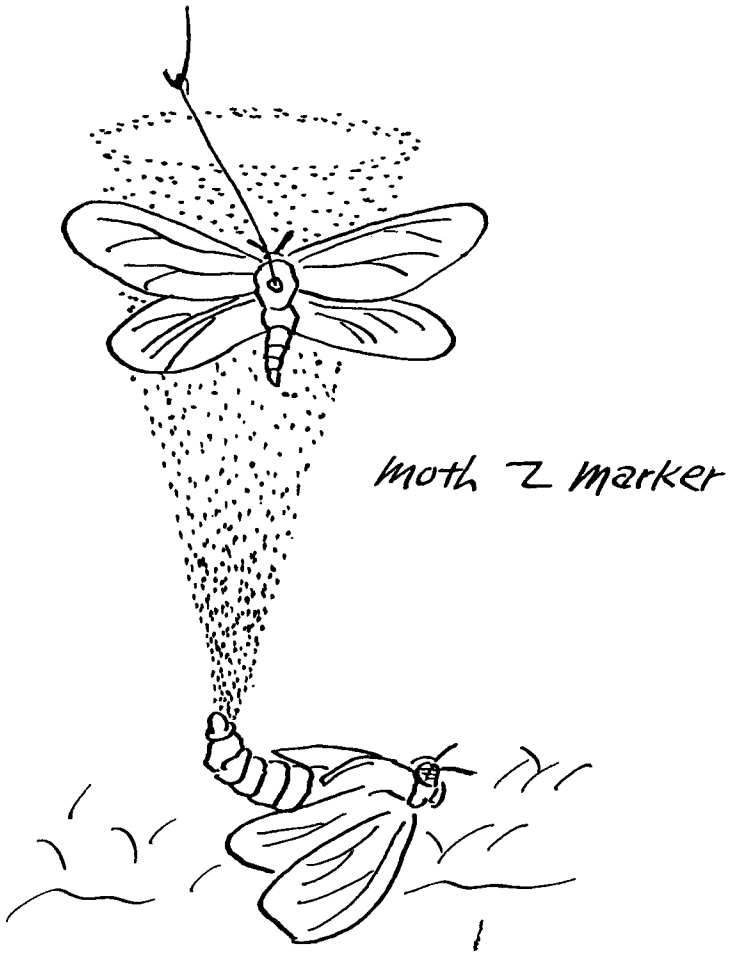
When the Philosopher was a boy his favorite fairy story told of a young lad that made friends with a dragon. The lad had learned enough about dragons and such things, that he knew that the real dragons are not fire-breathing ogres but rather huge, gentle, homely creatures, like elephants, that are fun to get to know.

The young lad's parents encouraged him to read books covering all of man's endeavors. The wise parents trusted his knowledge of dragons and so allowed him to make friends with the great beast. He, of course, saved the peasant village for they were dreadfully afraid of the dragon and wanted to kill it. That would have been a mistake for the great dragon would then have surely wiped the village out.

The Philosopher wished that the biologist would make friends with the physicist and vice versa. Like the lad and the dragon they might learn from one another and help save mankind by teaching man to understand his own dragon —modern technology.

The Philosopher learned a very important truth by reading the work of a great moth biologist. In E. B. Ford's beautiful book *Moths* the Philosopher read that English entomologists had discovered that over long distances the female ghost moth is attracted to the male instead of the other way around. She sees his white flashing wings at dusk just as the Philosopher did when he was a soldier at the Pullan Brae. When she arrives close to the male, she settles in the grass under him. Now, my dear reader, you see how the Philosopher knew immediately why the ghost moth has a short antenna. It is because the female is emitting her sex scent (pheromone) upwards into the air space under the hovering male. Hers is a close-in pheromone Z marker like the Z marker cone above the Belleek Radio Range Station.

Since the male is hovering over the female, he is vibrating —and carefully resonating his antenna—to her nonlinear infrared scent signal which in essence says "Come my love and let us lie together in the grass." The ghostly lover does not need to fly from afar to his mate for she is a liberated female and flies to him instead of vice versa. However, she



must still prove that she is an affectionate lady deserving of his spermatophore love gift. She releases her chemical love potion to flow gently upwards across his short vibrating antenna.

The Philosopher did not feel that he had invented any great system like John Tyndall or Nikola Tesla, but he did feel that he had discovered for the world something that God had given to all mankind. He believed that physicists might be able to use his discovery to build little transmitters to fool the insects that destroy his crops. If so, they could tune selectively to corn earworm moths, and cabbage looper moths, or even fire ants, and leave alone the ghost moth that feeds on dandelions and thistles, or the bees that make honey and pollinate man's food crops.

That would give the Philosopher great satisfaction, for men would no longer have to throw poisons around on good clean soil. It might even come to pass that rigid people who are against any kind of change, or any new idea, could sell the little traps and make as much money as they did selling their poisons. The Philosopher did not know if this could come to pass or not, but if it did he knew that there would always be hawks like Caesar in Witche's Woods. *He knew it in his heart because he had discovered the soul of the ghost moth!*

About the Author

Dr. Philip S. Callahan has devoted years to entomological and ornithological research, and is responsible for a number of breakthrough discoveries in both areas.

He is the author of six previous books, and has contributed over seventy articles on birds and insects to a wide variety of magazines and learned journals.

Son of an American Army officer and a mother of Spanish descent, Dr. Callahan was born at Fort Benning, Georgia. He served as a navigation and electronics specialist in World War II at a station in Ireland, where he played a crucial part in anti-submarine warfare. At the close of hostilities, he resumed his education at Fordham University, studied entomology at the University of Arkansas, and later at Kansas State University from which he received a Ph.D. in 1956.

Dr. Callahan is presently Insect Biophysicist with the Science and Education Administration (SEA) of the U.S. Department of Agriculture, and is also Graduate Professor of Entomology and conducts research at the University of Florida in Gainesville, where he lives with his family. His hobby is ornithology; he is particularly interested in birds of prey, and is a Master of Falconry. Dr. Callahan is also a Fellow of The Explorers Club.